BEARTOOTH-ABSAROKA WILDLIFE-MINING RESEARCH

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ABSTRACT

Wildlife populations on and adjacent to the "Stillwater Complex" mineralized zone in southcentral Montana were inventoried from September 1971 to July 1976 to obtain baseline data prior to major mineral extraction developments.

The elk herd on the Horseman Flats-Picket Pin winter range and the bighorn sheep herd wintering in the Stillwater Canyon were selected for intensive study. Data on production, survival, seasonal movements, range use and food habits were collected from these herds. The data were enhanced by following marked animals.

Less intensive data were collected from mule deer, white-tailed deer, moose, rocky mountain goats, black bear and blue grouse.

The results indicated the elk numbers were increasing, mule deer and moose were declining and the sheep herd remained stable or increased slightly. The goat numbers remained stable while production and/or survival of kids declined sharply.

Exploratory mining activity disrupted elk range use patterns on both the summer and winter ranges.

The study concluded that losses to wildlife due to the proposed mineral developments would be unavoidable.

INTRODUCTION

The "Stillwater Complex," a highly mineralized zone 30 miles long by 2-5 miles wide, was located along the northern edge of the Beartooth Mountains of southcentral Montana, approximately 80 miles southwest of Billings, near the town of Nye. The complex extended northwest from Little Rocky Creek (near Chrome Lake) across rivers and alpine plateaus to Mount Rae. Major drainages traversed included the Stillwater, West Fork of the Stillwater and Boulder Rivers. Elevations varied from 5000 feet along the valley floors to over 10,000 feet on Iron and Chrome Mountains. Vegetation ranged from streamside hardwoods through Douglas fir and subalpine forests to alpine meadows.

Exploration to date revealed the complex contained the largest known resource of chromite (90 percent of known reserves) in the Western Hemisphere and one of the largest known nickel-copper sulphide deposits in the United States. At least 19 percent of the known United States platinum group metal resources were also contained in the complex. In addition, smaller amounts of gold, silver and iron were present (Dayton 1971).

The Anaconda Company located mineral reserves of 150 million tons grading 0.25 percent nickel and 0.25 percent copper. The Johns-Manville

Sales Corporation announced sample results from the newly discovered West Fork mineralized zone averaging 0.5 troy ounces of platinum-palladium per short ton of ore. In addition, the samples contained 0.15 percent copper-nickel and minor amounts of gold and silver. Further exploration may prove the total mineral content to be higher than is now suspected.

Several attempts were made to develop this ore body. The Benbow and Mouat mines were briefly opened during World War II and the Mouat mine operated from 1952 to 1962. However, the low grade of the ore has thwarted attempts by private companies to economically develop the complex. Exploration by The Anaconda Company, Amax (American Metals Climax, Inc.) and Johns-Manville Sales Corporation were continuing.

The purposes of this study were to inventory existing game populations, obtain pertinent life history information on the various species and to predict, and possibly reduce, the impacts from future mineral development.

The study focused on two species, an elk *(Cervus canadensis)* herd that migrated through the complex and a bighorn sheep *(Ovis canadensis)* herd that wintered adjacent to the complex. Lesser amounts of data were gathered from mule deer *(Odocoileus hemionus)*, white-tailed deer *(Odocoileus virginianus)*, moose *(Alces alces)*, rocky mountain goats *(Oreamnos americana)*, black bear *(Ursus americanus)* and blue grouse *(Dendragapus obscurus)* populations.

During the course of this study an exploration adit (tunnel) was constructed adjacent to the elk winter range. This relatively small scale operation afforded an opportunity to better understand the nature and extent of the impacts to be expected from a major mining venture.

The procedures used were previously described in Stoneberg (1973, 1974 and 1975). Scientific names for plants mentioned in the text were presented in the Appendix. All relocations of animals marked during this study were compiled in a separate report that is available on request.

Mineral exploration and development of the "Stillwater Complex" was only one of many factors influencing game populations of the area. The present diverse fauna was a product of past natural and man-caused environmental changes. The effects of many of these past changes were still being manifest in the game populations. Attempts to determine the relationships between historic population fluctuations and past environmental changes were hampered by a lack of data.

The wildlife populations were responding to a complex matrix of interacting density-dependent and density-independent factors. Caution, therefore, should be used in interpreting the data and assigning cause and effect relationships between observed changes and only one of the influencing factors.

ELK

Summer Range

Location

The elk summered on the East Boulder Plateau between the main Boulder River and the West Fork of the Stillwater River (Figure 1). The summer range was in Sweet Grass County approximately 30 air miles south of Big Timber, Montana. Administration of the area was divided between the Gallatin and Custer National Forests.

Topography

The summer range included the northward sloping Breakneck Plateau and Placer Basin. Elevations gradually increased from 8500 feet in the north to over 9000 feet at the southern extreme. Breakneck, Iron, Picket Pin and Chrome mountains, at or near 10,000 feet elevation, ringed the plateau and basin.

The major drainage system of the summer range was the East Boulder River which flowed northward from the northern end of Breakneck Plateau through Placer Basin. Forge Creek, a major tributary, drained the eastern slopes of Chrome Mountain. Tributaries of the main Boulder River which originated on the plateau included North Fork of Hawley Creek, Miller Creek, Shorty Creek and Bobcat Creek. Hidden, Trail, Divide, Crescent and Iron Creeks flowed from the plateau to the West Fork of the Stillwater River.

Vegetation

The vegetation on the elk summer range generally followed South's (1971) descriptions for alpine and subalpine ecosystems. Major factors influencing vegetative composition and diversity were elevation, moisture, exposure, slope and soils.

Alpine

The alpine vegetative type was found on the higher points of Breakneck Plateau and on the surrounding mountain tops. This type was restricted to elevations over 9300 feet.

A low, mat-forming vegetative cover occurred on the exposed, rocky slopes and ridges at or near 10,000 feet elevation. The major components were dryas, pussytoes, sedges, lupine and mosses. Grass species, occurring in lesser amounts or scattered distribution, included bluegrasses, sheep fescue, alpine timothy, spike trisetum, and rushes. Associated forbs were bistort, sandwort, cinquefoil, golden aster, aster, fleabane, avens and elephant head.

The taller forbs were more abundant and diversified in protected areas and along water courses. Purple heather and to a lesser extent, yellow heather, were also found in the wetter areas.

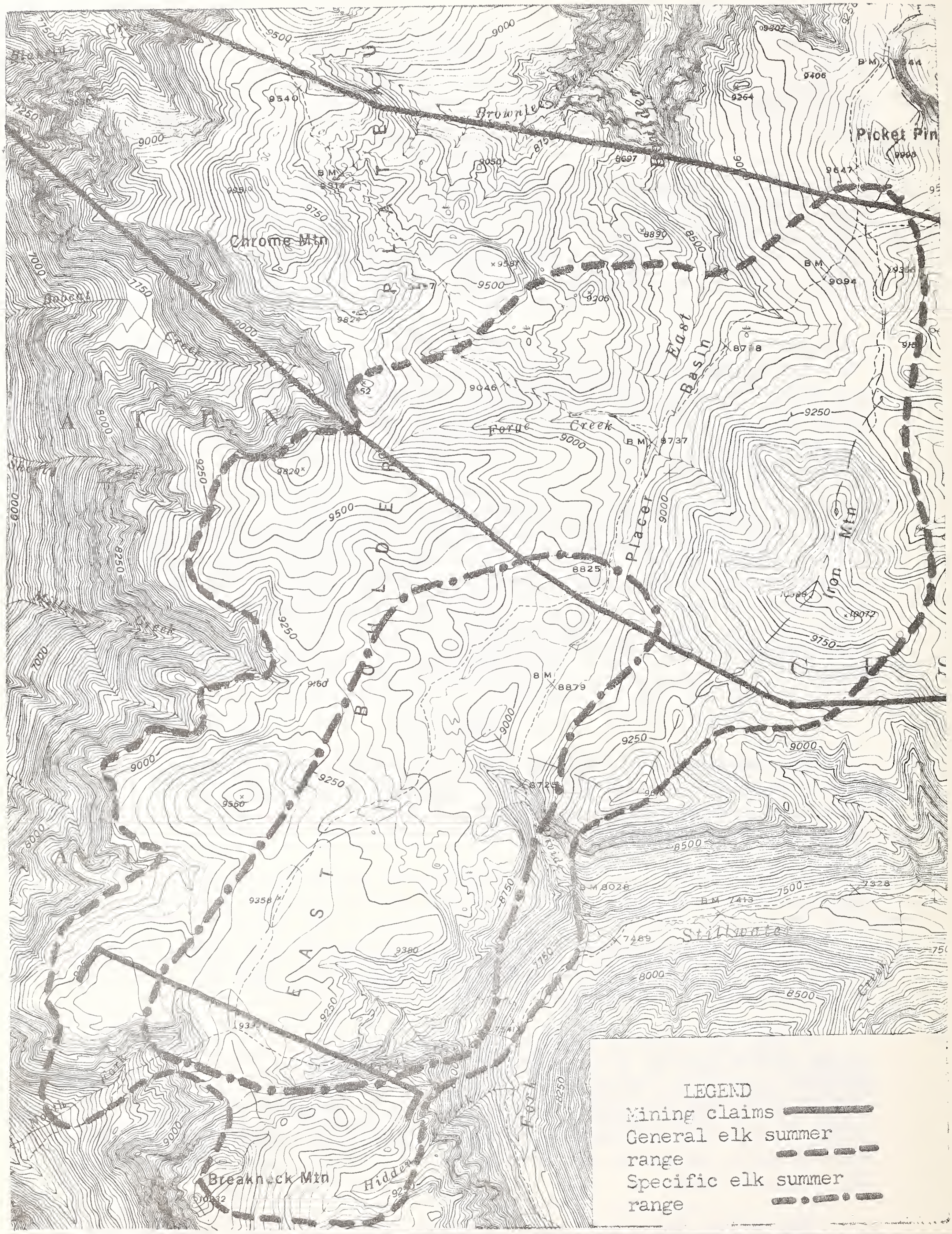


Figure 1. Location of the East Boulder Plateau elk summer range and the approximate boundaries of the mining claims.

Krumholtz

Between 9000 feet and 9500 feet elevation the true alpine graded to the subalpine. Many areas listed as alpine by South (1971) should have been included in this category. This was particularly true of Breakneck Plateau.

Scattered clumps of stunted, wind-shaped trees characterize this zone. Areas devoid of trees were included if they contained stumps and decaying tree remnants. The clumps were a mixture of white bark pine, alpine fir, and Engelmann spruce. Huckleberry formed the dominant ground cover under the trees.

In the open areas the vegetation varied according to the moisture. Forbs dominated the drier spots and sedges and grasses the wetter ones. Common forbs were lupine, pussytoes, cinquefoil, elk sedge, stonecrop, paintbrush, avens, aster, fleabane and hairbell. Less common or less widely distributed forbs included bistort, beards-tongue, sandwort, goldenrod, dryas, yarrow, false dandelion, clover, elk thistle, elephant head, vetch, chickweed, and anemone. The relative abundance of the forbs varied according to the seasons.

Sedges were found in all variations of the krumholtz type. They were dominant in the wetter areas. On Breakneck Plateau tufted hairgrass was abundant and formed thick stands in some areas. Bluegrasses were widely distributed while sheep fescue, Idaho fescue, alpine timothy, spike trisetum and timber oatgrass were of lesser importance. Rushes were abundant in the wet swales.

Aside from huckleberry, very few shrubs were found in this vegetative type. Willow occasionally occurred around boggy areas and along water courses. Shrubby cinquefoil and common juniper were rarely encountered.

Subalpine

The subalpine vegetative type occupied the majority of the elk summer range. Tree density accounted for the main variations within this type. Two subtypes, forest and meadow were identified.

The timber cover consisted of open stands of mature white bark pine and alpine fir. Lodgepole pine dominated some areas and Englemann spruce was found in most stands.

The dominant ground cover was huckleberry. Shrubby cinquefoil was occasionally encountered. Willow, purple heather and labrador tea grew in the wet, boggy areas.

Forbs were not abundant in this subtype. Common forbs were arnica, lupine, aster, slender hawkweed, pussytoes, bistort, cinquefoil, elephant head, ragwort, and paintbrush. Of lesser importance were gentian, sticky geranium, false dandelion, fleabane, camus, sandwort, elk sedge and beards-tongue. Forbs were locally important in the small openings in the timber and in the wetter areas.

Grasses were of minor importance in the understory flora. The main species were bluegrasses, sedges, rushes, tufted hairgrass, alpine timothy and spike trisetum.

Large open meadows in the subalpine type were of prime importance to the elk. These included Placer Basin, the head of Trail Creek and the head of the North Fork of Hawley Creek.

In Placer Basin the meadows were centered around the many branches of the East Boulder River. Small lodgepole pine trees were invading the openings. Boggy areas along the streams were primarily sedge meadows. Rushes and tufted hairgrass were fairly common, and timber oatgrass and alpine timothy were rare. The dominant shrub was willow. Forbs present included marsh marigold, aster, fleabane, groundsel, sticky geranium, pussytoes, elephant head, buttercup, dandelion and rose-root.

Sedges were also dominant on the drier knobs. Timber oatgrass was abundant and tufted hairgrass, rushes, bluegrasses, alpine timothy and spike trisetum occurred in lesser amounts.

Pussytoes were the main forbs followed by cinquefoil. Rose-root, stonecrop, elephant head and aster were scattered throughout these drier sites. Huckleberry was the only shrub observed.

The vegetation on the drier slopes was quite poor and probably reflected the heavy past use by domestic sheep.

Vegetation at the head of the North Fork of Hawley Creek was similar to the krumholtz type. The main grasses were tufted hairgrass, Idaho fescue and, in the wetter areas, sedges. Alpine timothy, bluegrass, spike trisetum and timber oatgrass were also present. Forbs were more important in the Idaho fescue areas. They included lupine, harebell, yarrow, false dandelion, clover, elk thistle, cinquefoil, goldenrod, stonecrop and elk sedge. Shrubby cinquefoil was fairly abundant on some slopes.

Vegetation on the open slopes along Trail Creek varied in species diversity and relative abundance according to slope and moisture. Sedges and tufted hairgrass were abundant in the wetter areas, while Idaho fescue dominated the drier sites. Other grasses included alpine timothy, spike trisetum, bluegrasses, bluejoint and wild rye. Mountain brome, needlegrass and timber oatgrass were also found at the base of an east-facing talus slope. Rushes were common in the wetter areas.

Lupine, ragwort, goldenrod and bluebell were abundant on the wetter sites. Other common forbs were yarrow, aster, pussytoes, bistort, clover, elk thistle, harebell, false dandelion, old man's whiskers, elephant head, beard-tongue and cinquefoil. Forbs with lower growth forms dominated the drier sites. These included pussytoes, camus, yarrow, vetch, harebell, false dandelion, sandwort, stonecrop, onion, flax, aster, elk sedge, elk thistle, old man's whiskers and anemone. One dry-to-wet site at the base of an east-facing talus slope added fireweed, monkey flower, sticky

geranium, dandelion, white sweet vetch, campion, arnica, cinquefoil and buckwheat to the list.

Shrubs were mainly found on the drier slopes and included shrubby cinquefoil, common juniper and bearberry. Willow was occasionally encountered along the stream channels.

The Trail Creek slopes had the most diversified flora of all the areas examined.

History of Land Use

Domestic Sheep Grazing

The East Boulder Plateau had a long history of domestic sheep use. The Forest Service grazing records began in 1922; however, sheep were probably in the area prior to this date. Although the records were incomplete, there were approximately 6000 head of sheep (lambs not included) using this area in 1922 (Table 1). Table 1 shows a continuous decline in the number of sheep from 1922 to the present. Major cuts occurred in 1933 and 1934 and in the early 1950's. By 1960, only 2,800 head were permitted. Since the 1969 grazing season, no sheep have used this area. However, two allotments still exist with a combined potential of 1900 head of sheep.

The length of the permitted grazing season varied considerably over the years (Table 1). Due to the high elevations, grazing was regulated mainly by weather and plant phenology, rather than by specified dates. In addition, two of the bands used lower allotments in conjunction with the higher ones. In general, sheep use in the high country varied from 20 to 60 days a year.

The area was divided into four allotments, each with one band of sheep (Figure 2). The Chrome Mountain, Iron Mountain and Placer Basin allotments were administered by the Gallatin (originally Absaroka) National Forest. The Trail and Hidden Creek allotment was administered by the Custer National Forest.

Chrome Mountain Allotment

Very little historical data were available for this allotment. From 1922 until 1955 Chrome Mountain was used in conjunction with the lower elevation Castle Creek allotment. In 1956 another lower elevation allotment, Lodgepole, was added and in 1957 the Castle Creek portion was dropped. From 1957 to the present, Chrome Mountain was used in conjunction with the Lodgepole allotment.

The Chrome Mountain portion of this range was reduced in size in 1965. The northern boundary was cut back to exclude the East Boulder Peak and Camp Lake areas and Chrome Mountain and Chrome Peak were typed as "unusable."

Sheep numbers were reduced from 1500 in the 1920's to 900 at present. The permittee elected not to use this allotment since 1969,

Table 1. History of domestic sheep use on the East Boulder plateau elk summer range.

Year	Iron No.[1]	Iron Season[2]	Chrome No.	Chrome Season	Placer No.	Placer Season	Trail & Hidden No.	Trail & Hidden Season	Total No.	Total A.M.[3]
1922	(1500)[4]	75	(1500)	75	(1500)	75	1500	90	6000	15750
23	(1500)	75	(1500)	75	(1500)	75	1300	75	5800	14500
24	1500	75	(1500)	75	(1500)	75	1300	60	5800	13850
25	1500	75	(1500)	75	(1500)	75	1300	60	5800	13850
26	1500	75	1500	75	1500	75	1100	60	5600	13450
27	1500	75	(1500)	75	(1500)	75	1100	60	5600	13450
28	1500	75	(1500)	75	(1500)	75	1100	60	5600	13450
29	1500	75	(1500)	75	(1500)	75	1100	60	5600	13450
30	1500	75	(1500)	75	(1500)	75	1100	60	5600	13450
31	1500	75	(1500)	75	1400	75	1100	60	5500	13200
32	1500	75	(1500)	75	1400	75	1100	60	5500	13200
33	1200	90	(1200)	90	1400	90	1100	60	4900	13600
34	1200	90	1200	90	1200	90	1100	60	4700	13000
35	1200	90	1200	90	1200	75	1100	60	4700	12400
36	1200	90	1200	90	1200	75	1100	60	4700	12400
37	1200	90	1200	90	1200	60	1100	60	4700	11800
38	1200	90	1200	90	1200	60	1100	60	4700	11800
39	1200	90	1200	90	1200	60	1100	60	4700	11800
40	1200	90	1200	90	1200	60	1100	60	4700	11800
41	1200	65	1200	65	1000	60	1100	60	4500	9400
42	1200	65	1200	65	1050	60	1100	60	4550	9500
43	1200	65	1200	65	1050	60	1100	60	4550	9500
44	1200	65	1200	60	1050	60	1100	60	4550	9300
45	1200	65	1200	65	1000	60	1000	60	4400	9200
46	1200	65	(1200)	65	NU		1000	60	3400	7200
47	1250	65	(1200)	65	NU		900	60	3350	7100
48	1200	55	(1200)	65	800	60	700	60	3900	7800
49	1000	65	(1000)	65	800	60	NU		2800	5934
50	1000	65	(1000)	65	NU		NU		2000	4334
51	1000	65	(1000)	65	-[6]		1000	60	3000	6334
52	1000	65	(1000)	65	-		1000	48	3000	5934
53	1000	65	1000	65	-		1000	48	3000	5934
54	1000	65	NU		-		1000	48	2000	3767
55	1000	65	700	55	-		1000	48	2700	5050
56	1000	65	1200	60	-		1000	48	3200	6167
57	1000	60	800	60	-		1000	48	2800	5200
58	1000	60	900	60	-		1000	48	2900	5400
59	1000	60	900	60	-		900	36	2800	4880
60	1000	60	900	60	-		900	36	2800	4880
61	1000	60	900	60	-		900	36	2800	4880
62	1000	60	900	60	-		NU		1900	3800
63	1000	60	900	60	-		900	36	2800	4880
64	NU[5]		900	60	-		NU		900	1800
65	NU		900	60	-		900	36	1800	2880
66	NU		900	60	-		900	36	1800	2880

Table 1 Continued. History of domestic sheep use on the East Boulder plateau elk summer range.

	Iron		Chrome		Placer		Trail & Hidden		Total	
Year	No.1/	Season2/	No.	Season	No.	Season	No.	Season	No.	A.M.3/
1967	NU		900	60	-		NU		900	1800
68	NU		900	60	-		NU		900	1800
69	1000	65	900	60	-		NU		1900	3967
70	NU		NU		-		NU		-	-
71	NU		NU		-		NU		-	-
72	NU		NU		-		NU			NU
73	NU		NU		-		NU			NU
74	NU		NU		-		-			NU
75	NU		NU		-		-			NU

1/ Total number of sheep permitted on allotment
2/ Length of season (days) permitted
3/ Total animal months permitted
4/ ( ) - No data available. Number of sheep permitted estimated
5/ NonUse of allotment
6/ Permit canceled

Iron Mountain Allotment

Iron Mountain was used in conjunction with a lower elevation allotment in the Deer Creek area. Although the records were incomplete prior to 1940, no major boundary changes apparently occurred.

Sheep use was reduced from 1500 head in the 1920's to 1000 head at the present. The 1969 grazing season was the last year the allotment was used.

In 1951, an extensive inspection of this allotment was made by Forest Service range personnel. They noted two portions that were in poor condition. One was on the west slope of Iron Mountain and the other was the small basin at the head of Iron Creek on the east slope of Iron Mountain. Both of these areas showed signs of severe deterioration - deep trails, terracing, slumping and patches bare of vegetation.

Reference was made to a 1945 inspection which concurred the range was in the same condition at that time. The 1958 report stated, "If the rest of this range looks as bad as this part (Iron Mountain) we have a real problem. All that is left on most of Iron Mountain is *Arenaria*." The range had not improved by 1961 when it was considered

Figure 2. Location of original domestic sheep grazing allotments on the East Boulder Plateau. (C.M. - Chrome Mountain allotment, I.M. - Iron Mountain allotment, P.B. - Placer Basin allotment, T.H.C. - Trail and Hidden Creek allotment.)

"one of the poorest ranges on the forest and should be eliminated if possible." In 1964, the permittee was persuaded not to use this range, and by 1967 it was felt some areas had improved and were very suitable for grazing, but the allotment would not support a 60-day permit. However, in 1969, 1000 head of sheep were allowed for 65 days. The permittee has not used this allotment since 1969. This was probably due to the economics of herding sheep in the high country.

Placer Basin Allotment

Placer Basin was administered as a separate allotment from the early 1920's to 1950. In 1951 this allotment was ended and portions of it were added to the Trail and Hidden Creek allotment. Sheep numbers declined from 1500 head in the 1920's to 800 head in 1949.

In 1939, the range was reported in good condition. By 1942, however, damage was recorded on the lower end of the North Fork of Hawley Gulch and recommendations were made to close this area. A 1945 report stated, "...a poor range characterized by pedestaled grasses, erosion pavements, terraces and gulches." It was concluded the North Fork of Hawley Creek should never have been alloted to sheep. Following 2 years of partial rest (1946 and 1947 Placer Basin was used by Chrome Mountain and Iron Mountain herds) the range had improved but was not considered fully recovered.

Trail and Hidden Creek Allotment

The number of sheep using this range was reduced from 1500 head in 1922 to 1100 head in 1926. The herd was further reduced to 1000 head in 1945 and to 900 head in 1959. This range was last used in 1966, and the permit was canceled in 1975.

From 1920 until 1950 this allotment covered the Custer National Forest portion of the East Boulder Plateau. In 1951 it became an interforest allotment when portions of the Placer Basin allotment were added. The head of the North Fork of Hawley Creek and Breakneck Mountain were posted against grazing in 1954. In the early 1960's, Breakneck Plateau was also removed from grazing.

Range inspection reports, dating back to 1943, indicated varying degrees of overuse. The 1943 Management Plan considered this allotment, with few exceptions, to be adaptable to sheep use. The main exception was Breakneck Plateau, where sheep were suspected of contributing to wind and water erosion. The Trail Creek portion was considered the best sheep range on the unit, and Hidden Creek was underused. The range reportedly improved through 1947, when it was "not overused at any place." However, the 1948 report indicated it had been badly used in the past.

The range was not used in 1949 and 1950, and portions of the Placer Basin allotment were added in 1951. By 1957, considerable soil erosion was evident, Hidden Creek was listed as marginal, and Placer Basin was considered the only area that would support grazing. The 1959 Management Plan confirmed the earlier findings that Placer Basin was the only area suitable

for grazing. However, in 1962 the Placer Basin range trend was down. Sheep have used this allotment for only three seasons (1963, 1965 and 1966) since 1962. In 1975 the permit was canceled.

Present and Future

Scars from heavy sheep use in the past were still evident in 1976. The wet, deeper soiled, sedge meadows were characterized by rough, hummocky terrain. In low spots where breaks in the sod cover occurred, standing water prevented revegetation. The hummocks were probably produced by frost action. The sheep may have contributed to this by compaction and by removing the protective vegetative cover. Vehicle traffic produced many of the breaks in the sod. This terrain was most evident along the water courses of Placer Basin.

In the drier areas, sparse vegetation interspersed with barren sod was a remnant of past overuse. Revegetation was extremely slow. Where the sod cover had been removed, wind erosion resulted in coarse gravel beds. Isolated clumps of sod indicated these areas were once vegetated. Revegetation of these areas was nonexistent.

The Gallatin National Forest recently reevaluated all sheep grazing allotments. Portions of the East Boulder Plateau were considered suitable for limited sheep use. It was recommended between 700 and 800 head be allowed to graze Placer Basin and Chrome and Iron Mountains for a 40-day season (J. Light pers. comm.). Although the area may support this use, severe restrictions and strong enforcement would be necessary to prevent localized damage.

The open meadows of Placer Basin showed the poorest recovery of all areas on the plateau. The abundance of timber oatgrass indicated this range was in poor condition. Placer Basin should not be opened to sheep grazing in the near future.

The fragile nature of these alpine and subalpine ranges coupled with the economic restraints of herding sheep in the high country, should preclude the classification of any portion of the East Boulder Plateau as suitable for domestic sheep grazing.

Mining

The Placer Basin-East Boulder Plateau area was prospected as early as 1869 (Annin 1964). Individuals, primarily interested in gold, continued to explore this region, but development was limited to a few tunnels. In 1942, domestic sheep herders complained of the numerous claims, survey parties and miners on their allotments (U. S. Forest Service files).

Prior to 1958, access to this area was limited to trails. In 1958, U. S. Steel Company constructed a road up the Picket Pin drainage to Iron and Chrome Mountains. They claim-staked extensively and obtained numerous ore samples, then abandoned the area in the mid-1960's.

Several major mining companies restaked the U. S. Steel Company claims in the late 1960's. Lingren (for Texas Gulf Sulfur) and Cypress Mines Corporation were active for a short time, then abandoned their holdings. Amax (American Metal Climax, Inc.) and Johns-Manville Corporation began prospecting in 1967.

The Anaconda Company staked claims on the northwest side of Chrome Mountain and the southeast side of Iron Mountain in the late 1960's. Since 1971, activity on the Anaconda claims has been on a reduced scale and consisted mainly of reclamation and some core drilling.

The Johns-Manville Corporation was primarily interested in the platinum-palladium group minerals. Initial exploration produced encouraging results from the Picket Pin Mountain area. This led to extensive claim staking and sampling. In 1973 and 1974 a platiniferous ore zone was located at the head of Iron Creek, east of the East Boulder River. Also in 1974, geochemical sampling along the West Fork of the Stillwater River revealed a mineralized zonal outcrop. Subsequent tracing and sampling of the latter zone indicated a significant deposit of platinum-palladium minerals. An exploration adit (tunnel) was started in December 1974 adjacent to the West Fork of the Stillwater River near the mouth of Cathedral Creek. The adit will extend for approximately 3,000 feet along the strike of the mineralized zone and will produce a bulk ore sample of about 1,000 cubic yards.

In 1975 the Johns-Manville Corporation began exploring the region around Hawley Mountain. Exploration continued in 1976 when Breakneck Mountain, the southern end of Breakneck Plateau and portions of Trail and the North Fork of Hawley creeks were claim-staked. Apparently uranium was the focus of interest in this region and it was probably not associated with the "Stillwater Complex." Transportation to these claims was entirely by helicopter.

Amax began claim-staking in 1968 and by 1975 had 248 contiguous claims. Diamond drilling was begun in 1970 and was continuing through 1976 (Hoy 1976). Activities on the Amax claims were limited to exploration and reclamation. No plans have been announced for development. However, as Hoy (1976) pointed out, "we believe that future planning for the Iron and Chrome Mountain areas should include the possible use for mineral production, particularly for nickel and copper."

Should Amax develop their claims, potential impacts would include rerouting access roads, waste rock disposal, mill tailings disposal, strip mines and water supply storage ponds (Hoy 1976).

Mining activity on the East Boulder Plateau was primarily limited to the summer months. The road was generally opened by late June and the camps were abandoned by November. In 1974, three semipermanent camps were in operation - one for Amax and two for Johns-Manville. Johns-Manville abandoned one camp in 1976.

An extensive road system was built to service the exploration activities. The roads, however, did not extend south of a line between Iron and Chrome Mountains. In 1973 the Forest Service erected barriers and posted signs to legally close a jeep trail that extended south into Placer Basin and onto Breakneck Plateau.

Elk History

Elk apparently did not use the East Boulder Plateau during the early 1900's. One sheepherder (T. Haugen pers. comm.) claimed there were no elk present in the late 1930's. A former Forest Service employee (R. Watters pers. comm.) first sighted elk on Breakneck Plateau in 1949. The Forest Service range inspection reports (which generally included game sightings) did not mention elk until 1952 when 5 bulls were seen on Breakneck Mountain and 3 head were observed in Placer Basin. Thereafter they were commonly mentioned in the Trail and Hidden Creek allotment reports. They were never mentioned, however, in the Iron Mountain or Chrome Mountain reports.

The elk herd apparently increased during the 1950's and in 1962 the Forest Service counted 37 head and estimated 60 head were using Breakneck Plateau. In 1963, 74 elk were observed at the head of the North Fork of Hawley Creek (Forest Service pers. comm.) and in 1968, 78 elk were observed in the same area (Montana Department of Fish and Game files). Since 1972, this herd was extensively censused and the high counts for 1972, 1973, 1974, 1975 and 1976 were 94, 118, 127, 126 and 111 head (Picton pers. comm.), respectively.

The data suggest elk did not use the East Boulder Plateau summer range during the years of high domestic sheep numbers. Elk first appeared following the reduction of sheep use on the Placer Basin and Trail and Hidden Creek allotments. In the 5-year period from 1941-1945, 10,550 sheep used these two allotments. During the next 5 years, 1946-1950, only 4,200 sheep used the same area. This represented a 60 percent decrease. As sheep use continued to decline, elk numbers increased.

Domestic sheep numbers were not significantly reduced during this period on the Iron Mountain and Chrome Mountain allotments. From 1941-1945, 12,000 sheep used these ranges and from 1946-1950, 11,250 sheep (a 6 percent decrease) used the same area. This may explain why elk were not observed on these allotments.

As sheep numbers declined in the late 1950's and throughout the 1960's, exploratory mining activity increased dramatically. The camps, vehicular traffic and drill rigs probably prevented the elk from spreading to the northern portion of the East Boulder Plateau.

Distribution of Elk on Summer Range

In 1969, 1970 and 1971, Gordon (game biologist, Montana Department of Fish and Game) conducted aerial surveys of the East Boulder Plateau elk

Trail Creek elk summer range.

Dry slope in Placer Basin showing effects of past overuse by domestic sheep.

summer range. In 1969, only one elk was observed north of Breakneck Plateau. In 1970, all sightings were either along Trail Creek or the North Fork of Hawley Creek. During a flight in 1971, he observed 33 elk at the south end of Placer Basin and remarked this was the furthest north he had seen a large group of elk.

In 1972 Knapp (1973) intensively studied elk distribution on this summer range. Although he found elk and elk sign over most of the East Boulder Plateau, very few were observed north of the exploratory mining boundary. He located two main areas of elk use, Placer Basin and Breakneck Plateau. A herd of between 16 and 20 animals was observed repeatedly in Placer Basin. A larger herd (approximately 90 head) was observed using Breakneck Plateau and adjacent Trail and North Fork of Hawley creeks.

Aerial and ground reconnaissance were used from 1973 through 1976 to determine elk distribution on the summer range (Stoneberg 1974 and 1975). The majority of elk in all years was observed along Trail Creek. Elk were noticeably absent from the North Fork of Hawley Creek in 1974 and from Breakneck Plateau in 1973. Although tracks and droppings indicated they used the Hidden Creek basin, elk were only observed there in 1974 (Table 2).

Table 2. Comparison of elk observations from specific areas of the East Boulder plateau summer range 1973-1976.1/

Area	1973	1974 2/	1975	1976 3/
Trail Creek	50%	71%	62%	40%
N. Fork Hawley Creek	28	3	15	17
Breakneck Plateau	4	21	22	23
Hidden Creek	0	3	0	0
Placer Basin	18	1	1	12
Iron-Chrome Mountains	tr 4/	1	0	8
Total elk observed	669	1182	695	512
Maximum number observed during one flight	118	127	126	111

1/ Aerial and ground observations combined.
2/ 1974 data were recalculated and differ slightly from that presented in Stoneberg (1975).
3/ Combined observations of Stoneberg, Simmons (pers. comm.) and Picton (pers. comm.).
4/ Trace - less than 1 percent.

The meadows along Trail Creek and the North Fork of Hawley Creek and the plateau between them generally accounted for over 80 percent of the summer elk sightings. Considerable use was recorded for Placer Basin in 1973 and 1976. Few elk were observed in this area in 1974 and 1975.

A shift in use patterns was noted in 1976. Counts in late June and early July indicated elk were using the traditional ranges of Trail Creek and North Fork of Hawley Creek (Table 3). However, by late July they were scattered in small bunches throughout the summer range. Use of Trail Creek diminished and observations in Placer Basin and between Iron and Chrome Mountains increased. In addition, 42 percent of the elk observed on Breakneck Plateau were at the extreme northern end. Only 50 percent of all elk sightings in late July and August were in the Trail Creek, North Fork of Hawley Creek and the southern end of Breakneck Plateau area. This compared with 91 and 99 percent for the same time period in 1974 and 1975 (Table 3).

Table 3. Comparison of elk observations from specific areas of the East Boulder plateau summer range prior to July 13 and after July 13, 1974-1976.1/

	1974		1975		1976	
Area	Before 7/13	After 7/13	Before 7/13	After 7/13	Before 7/13 2/	After 7/13 3/
Trail Creek	94%	56%	84%	55%	78%	9%
N. Fork Hawley Cr.	4	2	16	15	17	16
Breakneck Plateau	2	33	0	29	1	42
Hidden Cr.	0	5	0	0	0	0
Placer Basin	0	2	0	1	0	21
Iron-Chrome Mtns.	0	2	0	0	4	11
Total elk observed	448	734	173	522	232	280
Maximum number observed during one flight	127	114	112	126	111	65

1/ Aerial and ground observations combined.
2/ Combined observations of Stoneberg, Simmons (pers. comm.) and Picton (pers. comm.).
3/ Combined observations of Stoneberg and Simmons (pers. comm.).

The disruption of elk distribution on the summer range in 1976 coincided with claim-staking of Breakneck Plateau. The area was staked by Johns-Manville Sales Corporation on or near July 13, 1976. The disruption was probably due to on-the-ground activities, rather than the extensive helicopter service flights.

The distribution of elk on the East Boulder Plateau summer range was apparently influenced by domestic sheep grazing and exploratory mining activity. Elk were not in this area during the years of heavy overuse by domestic sheep. As sheep numbers at the southern end of the plateau decreased, elk numbers increased. High sheep numbers on the northern allotments probably prevented the expansion of elk range to these areas. As the sheep numbers on Iron and Chrome Mountains declined, exploratory mining increased.

By 1970, exploratory mining was the major factor influencing elk distribution. Studies since 1970 indicated elk mainly used the extreme southern end of Breakneck Plateau and the adjacent side drainages. This area was the furthest point from the exploratory mining activity. The impact of this disturbance was further exemplified when this key area was claim-staked in 1976. The elk dispersed into small groups and a general northward movement was noted. A behavioral change was also observed. Prior to 1976, elk were observed during early morning flights feeding and bedding on the open plateau and in the large, open meadows along the side drainages. With the onset of the breeding season (late August-September) they shifted to the timber edge and open timbered areas.

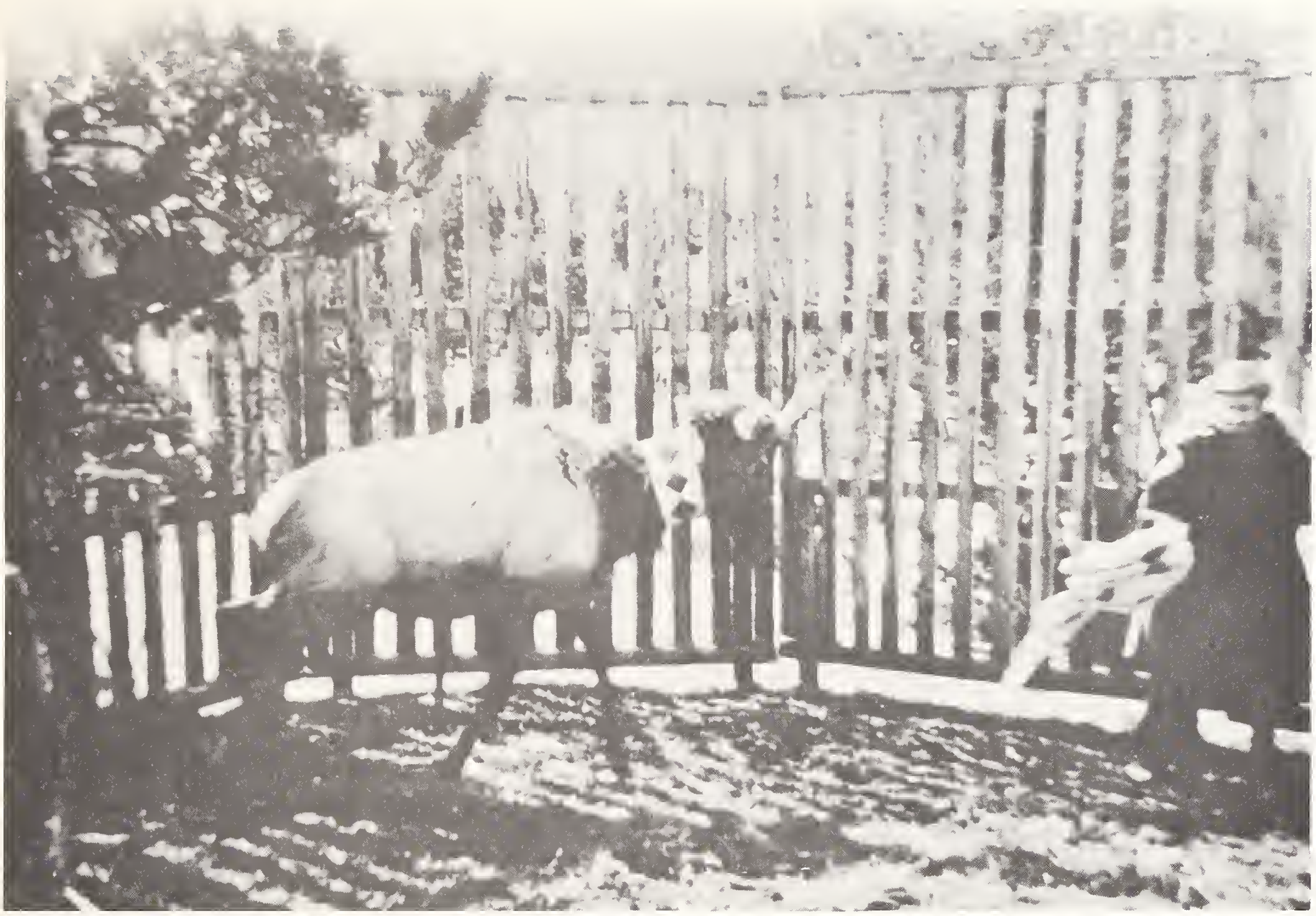
In late July and August 1976, most observations were in the timber edge and open timber habitat types. In addition, those spotted on the open plateau were generally running for the timber. The elk definitely avoided the open areas in late summer 1976.

If mineral exploration continues in the Iron Mountain-Chrome Mountain area and if exploratory activity increases on the southern end of Breakneck Plateau, the elk summer range will be reduced to the areas of Placer Basin and the northern extreme of Breakneck Plateau. For this reason, domestic sheep should not be allowed south of the mineral boundary between Iron and Chrome Mountains.

Movements of Elk on the Summer Range

Elk generally began appearing on the summer range in late June. The early arrivals used the lower slopes of Trail Creek and the North Fork of Hawley Creek. They moved up these drainages following the receding snowline. Breakneck Plateau was not heavily utilized until mid-July.

Marked animals provided data on movements of individual elk on the summer range. Fourteen elk were trapped and neckbanded on the Horseman Flats winter range in 1973 and 1974 (Stoneberg 1974). In addition, two elk from the Boulder River winter range were individually recognizable. One was wearing a Yellowstone National Park neckband and the other had an almost pure white pelage.



In summer 1973, only one neckbanded yearling bull (No. S2297) was observed (Figure 3). His movements indicated elk readily moved from one portion of the winter range to another.

In 1974, 10 neckbanded elk were repeatedly observed on the summer range (Table 4). Ninety-five percent of the relocations were from Breakneck Plateau and the adjacent side drainages. Seventy-nine percent of the sightings were from the Trail Creek area.

Seven of the neckbands were observed only along Trail Creek and on Breakneck Plateau and one was seen twice along the North Fork of Hawley Creek. An adult female (No. S3544) was along Trail Creek on July 28. On August 1, she was observed on Iron Mountain and by August 22 she was back on Trail Creek. Another adult female (No. 174) moved from Trail Creek to Placer Basin and back to Trail Creek between August 22 and September 3. She was back in Placer Basin on September 23 and was observed in Breakneck Park (mouth of Trail Creek) on October 17.

These data supported earlier findings that the southern end of Breakneck Plateau and the adjacent side drainages (particularly Trail Creek) were the key areas of the elk summer range. They also indicated that some elk traveled freely between specific areas of the summer range.

Table 4. Summer range relocations of elk banded on Horseman Flats 1974-1976.1/

Date	S3544	S3548	172	173	S3549	S2295	174	S3546	S3545	164
6/15/74			TC2/							
6/19/74								TC		
6/24/74		TC	TC		TC					
7/ 1/74	TC	TC	BP	TC	TC	TC	TC	TC	TC	TC
7/ 8/74		TC	TC	TC	TC	TC	TC	TC	TC	TC
7/11/74	TC					TC	TC	TC	TC	
7/22/74		BP	TC		BP	TC	BP	BP	TC	TC
7/28/74	TC			TC	TC	TC			TC	BP
8/ 1/74	IM	TC		TC	TC	TC	TC	TC	TC	TC
8/ 4/74				TC	TC					TC
8/11/74										NFHC
8/22/74	TC	TC				TC	TC		TC	TC
8/27/74		BP			BP	BP	PB	BP	BP	BP
9/ 3/74		TC					TC	TC	TC	TC
9/14/74	PB									
9/23/74							PB		TC	
10/17/74			TC		TC	TC	TC	TC		NFHC
11/ 4/74					TC			TC		
7/10/75	-3/	-	-	-				TC		
7/18/75	-	-	-	-				TC	TC	BP
7/23/75	-	-	-	-		TC	PB	BP		TC
8/ 6/75	-	-	-	-		BP				
8/21/754/	-	-	-	-		HC			HC	
8/27/75	-	-	-	-		NFHC	TC		TC	
9/15/75						TC				
6/10/754/	-	-	-	-	-					TC
6/29/76	-	-	-	-	-	TC5/				TC
7/ 6/764/	-	-	-	-	-		TC			TC
7/24/76	-	-	-	-	-	PB				
7/26/76	-	-	-	-	-				PB	
8/ 6/76	-	-	-	-	-					CM
8/14/765/	-	-	-	-	-		CM			
8/27/76	-	-	-	-	-		PB			

1/ Aerial and ground observations combined.
2/ Specific area of observation. TC = Trail Creek, BP = Breakneck Plateau, PB = Placer Basin, NFHC = North Fork of Hawley Creek, HC = Hidden Creek, IM = Iron Mountain, CM = Chrome Mountain.
3/ - = Known mortality.
4/ Data from Picton (pers. comm.).
5/ Data from Simmons (pers. comm.).

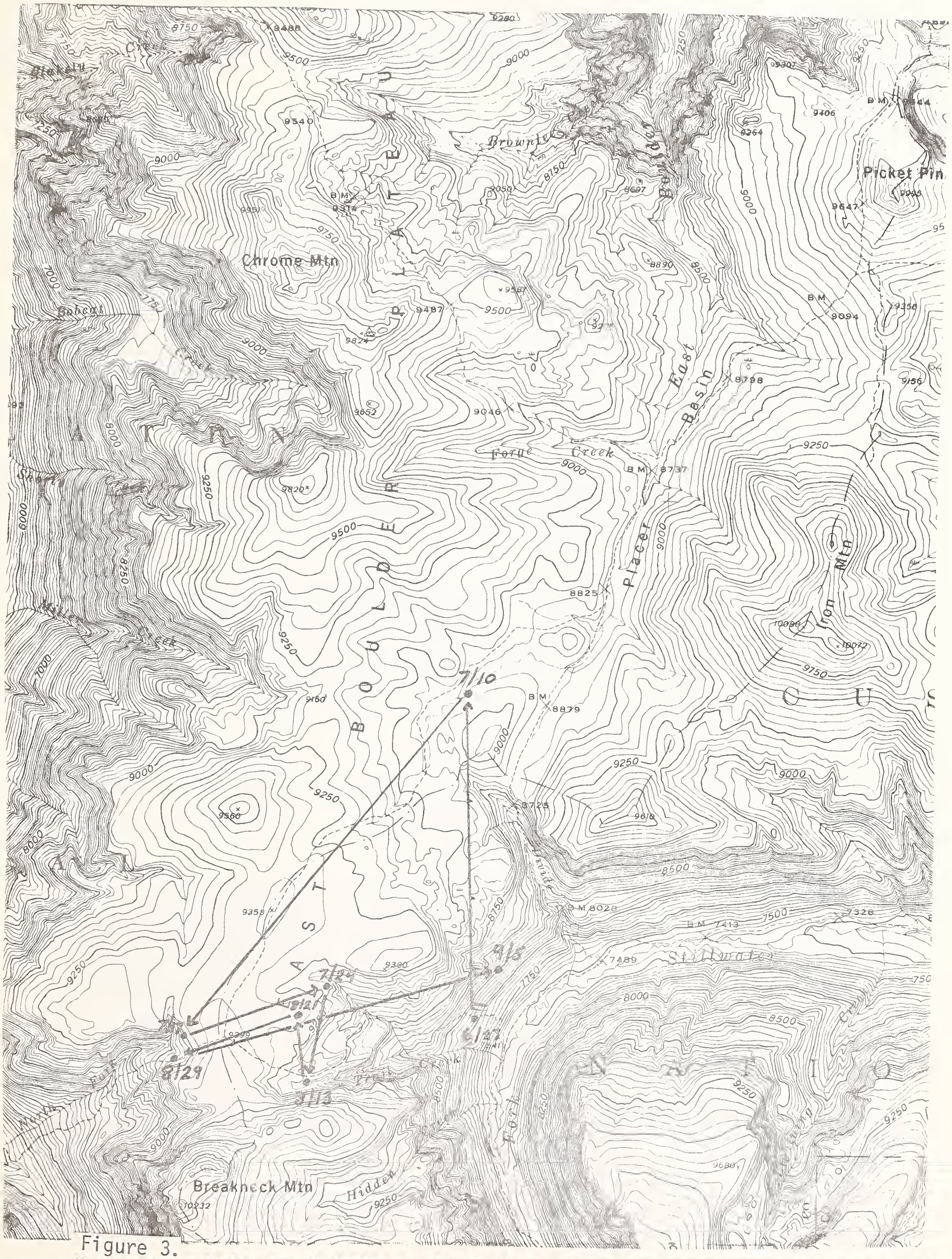


Figure 3.
Movements of elk No. S-2297 on the East Boulder plateau summer range in 1973.

In 1975, the elk were late arriving on the summer range. In addition, poor flying conditions during the summer months reduced the number of relocations (Table 4). Of 15 resightings, only one was north of Breakneck Plateau.

The limited data from 1976 further exemplified the shift in use patterns. In late June and early July all sightings were from the Trail Creek area. In late July and August all band relocations were north of Breakneck Plateau. The paucity of data were partially due to the elk being scattered throughout the open timbered areas of the summer range.

On July 24, 1973, a cow elk was observed at the head of Trail Creek wearing a rope-style neckband. It was later learned this elk had been observed wintering along the Boulder River and her pendant number was 97 (Gordon pers. comm.). A check of the Yellowstone Park banding records (Craighead et al. 1971) revealed she was an adult cow when banded in the Slough Creek trap on January 11, 1967. This trap was located just north of the confluence of Slough Creek and the Lamar River in Yellowstone National Park.

She was observed twice along Trail Creek in both 1974 and 1975. On all occasions she was in the same herd as neckbanded animals from the Horseman Flats winter range. She was last sighted on July 23, 1975 and was not seen in 1976.

An almost pure white cow elk was first observed along the North Fork of Hawley Creek on July 17, 1973. This elk had also been observed wintering along the Boulder River (Gordon pers. comm.). On July 1, 1974 she was sighted along the North Fork of Hawley Creek with a normally colored calf. On July 8 she had moved to Trail Creek and was in the company of nine neckbanded elk from Horseman Flats. She stayed in the Trail Creek/Breakneck Plateau area through July and was last seen on Trail Creek on August 1, 1974.

This cow was not observed on the summer range in 1975. On July 6, 1976 Picton (pers. comm.) recorded a "piebald" female elk in the Trail Creek area. On August 11, 1976 a white-colored cow was observed crossing Breakneck Plateau, accompanied by a normally colored calf.

Data from the marked animals indicated the elk generally returned to the same summer range each year. One cow (No. S2295), banded on Horseman Flats on January 31, 1973, was never resighted during the summer of 1973. She was repeatedly seen on the East Boulder Plateau in subsequent summers. A bull (No. S3549) was frequently seen in 1974, the first summer following banding. On June 25, 1975 he was part way up Picket Pin Creek migrating between the winter and summer ranges. He was never observed on the summer range in 1975 and was harvested, on the winter range, on October 20, 1975. The white cow was observed in 1974 and 1976 but not in 1975.

Although it was probable these animals were on the summer range and were simply not seen, the possibility existed other areas may have been used, at least temporarily, for summer range.

The data also indicated elk from the Boulder River and from the Horseman Flats winter ranges mixed freely on the summer range.

Herd Size

An attempt was made to compute the average monthly herd size for the years 1973 through 1976 (Table 5). Only aerial observations were used. Determining what constituted a herd presented numerous difficulties. The elk were often scattered in small groups over a relatively small area. The smaller groups frequently coalesced and larger groups split during the period of observation. For continuity of data, all elk observed in one general area were considered a herd.

Table 5. Average monthly herd sizes for all aerial observations of elk on the East Boulder Plateau summer range 1973-1976.1/

	1973	1974	1975	1976 3/
June	55(1) 2/	37(4)	12(2)	30(4)
Range	-	72-14	14-10	44-17
July	44(5)	54(8)	41(9)	24(4)
Range	109-2	114-3	115-4	32-14
August	35(9)	34(9)	57(3)	16(11)
Range	100-3	93-1	95-10	43-4
September	21(2)	18(6)	33(4)	-
Range	30-11	73-1	56-12	-
Average for Summer	37(17)	37(27)	39(18)	20(19)
Average for July & August	39(14)	43(17)	45(12)	18(15)

1/ Observations from fixed-wing aircraft and helicopter.
2/ Average herd size (number of herds observed).
3/ Includes data from Simmons (pers. comm.).

The June averages in Table 5 only included elk observed on the summer range. Since they were migrating at this time, counts depended to some extent on snow conditions. In 1974 and 1976, early spring years, large groups of elk were on the summer range by late June. The late spring of 1975 retarded their movements by at least 2 weeks.

In general, the average herd size peaked in July, then declined through August and September. A small sample indicated elk remained bunched through August in 1975. The data in Table 5 supported the general observation that

elk were concentrated at the southern end of the summer range through July. In August small groups dispersed to other areas of the plateau. The dispersion increased during September as harems were formed and they began moving toward the winter range.

In 1976, the average herd size for July and August was considerably smaller than what had been observed in previous years. The counts were made after Breakneck Plateau was claim-staked by Johns-Manville Corporation on or about July 13, 1976. In addition, the June average prior to claim-staking was higher than the July and August figures. Picton (pers. comm.) observed 96 elk in one group on July 6, 1976. The average herd size for this flight was 28.

These data indicated the exploratory mining activity may have changed the herding patterns of the elk. Rather than concentrating at the southern end of the range, they were scattered in small groups throughout the plateau.

Population Dynamics

Production and Survival

When possible, all elk sighted on the East Boulder Plateau summer range were classified to age and sex. The majority of the sightings each year were made from an aircraft. It was noted more bulls were generally recorded during observations from the ground and from a helicopter than from a fixed-wing aircraft. Spike bulls were often difficult to distinguish from the air due to the topography, vegetative cover and air currents. For these reasons, production values were listed as calves/100 adults.

Large herds (90-100 animals), concentrated on a small area, were frequently observed from the air. The accuracy of the total counts and classifications often depended on the flying conditions. In other cases, the elk drifted to the timber before counts and classifications were completed.

Groups of calves were often observed bedded a short distance from the grazing adults. These groups may have been missed on occasion, particularly if they were in the timber. This would explain the unusually low production observed during some flights.

All recorded age classifications from 1962 through 1976 were presented in Table 6. The ratio ranged from 19 calves/100 adults in 1962 to 40 calves/100 adults in 1976, and averaged 32. No trends were noted in the cumulative production data through 1976.

Stoneberg (1974 and 1975) and Table 7 listed all classifications from 1973 through 1976. Considerable variation occurred between some observations. To partially alleviate this, the data were lumped by month (Table 8). In all years, except 1975, the highest calves/100 adults ratio was in July. Knight (1970) felt the July ratios were more representative of the Sun River elk population than the cumulative ratios for the entire summer. However, his ratios increased as the summer progressed. On the East Boulder Plateau the ratio either remained stable or decreased from July to August in all years.

Table 6. Age classifications of elk on the East Boulder plateau summer range 1962-1976.

Year	Adults	Calves	Uncl.	Calves/ 100 Ad.	Calves/ 100 Cows	Total	Highest Single Count
1962 1/	31	6	-	19	23	37	37
1968 2/	54	21	3	39	40	78	78
1969 2/	34	11	5	32	34	50	50
1970 2/	79	30	-	38	-	109	90
1971 2/	27	6	-	22	27	33	33
1972 3/	-	-	-	(32) 3/	38	307	94
1973 4/	382	119	-	31	40	501	118
1974 4/	912	334	-	37	41	1246	127
1975 4/	608	204	-	33	38	712	125
1976 4/	191	75	-	40	-	266	69

1/ Source: U. S. Forest Service files.
2/ Source: Montana Department of Fish and Game files.
3/ Source: Knapp (1973) (calves/100 Ad. estimated from data).
4/ Source: Data collected during this study - aerial and ground observations combined.

The data from Table 8 indicated calves/100 adults ratios for July and August increased slightly from 1973 through 1976. Assuming approximately 100 adults were using this summer range, then about 40 calves were produced during the last 2 years. This probably more than offset natural and hunting mortality and ensured the continued maintenance and, possibly, growth of this herd.

Sex Ratios

Accurate sex ratios for the elk using the East Boulder Plateau summer range were difficult to obtain. Few bulls were generally seen during the summer flight counts. This may have been due to: (a) spike bulls were less visible from an airplane, (b) bulls may have been summering on different areas than cows, or (c) there was a lack of bulls in this area.

The difficult flying conditions usually prevented accurate sex classifications. This was particularly true when large groups of elk were censused. In general, branch-antlered bulls were readily distinguishable while spike bulls were often overlooked. Observations of neckbanded spikes exemplified this problem. They were frequently indistinguishable from cows due to poor light conditions and distance of observation.

Several authors (Knight 1970, Zahn 1974 and Lemke 1975) indicated bulls formed separate groups on the summer range. Yearlings, however, were frequently observed with cow/calf groups. Biggins (1975), following radioed elk,

Table 7. Age classification of all elk observations on the East Boulder Plateau summer range 1975 and 1976.[1]

Date	Adults	Calves	Uncl.	Calves/ 100 Ad.	Total
6/17/75[2]	34	7	-	21	41
6/25/75	43	19	-	44	62
7/ 2/75	38	13	-	34	51
7/10/75	59	28	-	47	87
7/11/75	34	8	-	24	42
7/18/75	89	37	-	42	126
7/23/75	83	15	-	18	98
8/ 6/75	67	28	-	42	95
8/27/75	62	15	-	24	77
9/ 5/75	67	24	-	36	91
9/26/75	32	10	-	31	42
1975 Total	608	204	-	33	812
6/29/76[2]	51	18	-	35	69
6/29/76[3]	47	15	-	32	62
7/ 6/76[4]	59	33	19	56	111
7/24/76	40	16		40	56
7/26/76	9	5	25	56	39
8/ 6/76	43	17	-	40	60
8/11/76	46	19	-	41	65
8/13/76[3]	11	3		27	14
8/14/76[3]	34	10	-	29	44
8/27/76	2	-	-	-	2
1976 Total	342	136	44	40	522

1/ Aerial and ground observations combined.
2/ June counts include elk migrating to summer range.
3/ Data from Simmons (pers. comm.).
4/ Data from Picton (pers. comm.).

Table 8. Monthly calves/100 adults ratios from the East Boulder Plateau elk summer range 1973-1976.[1]

Month	1973		1974		1975		1976	
	Calves/ 100 Ad.	Total No. Classified	Calves/ 100 Ad.	Total No. Classified	Calves/ 100 Ad.	Total No. Classified	Calves/ 100 Ad.	Total No. Classified
June	-	-	32(44)	200(99)	34(44)	103(62)	35(35)	69(69)
July	32(30)[2]	339(118)[2]	42(37)	520(127)	33(42)	404(126)	43(40)	70(56)
August	29(29)	121(71)	38(37)	340(101)	33(42)	172(95)	40(41)	125(65)
September	32(32)	41(41)	23(26)	116(73)	34(36)	133(91)	-	-

1/ Aerial and ground observations combined. Includes elk migrating to and from the summer range.

2/ Monthly total (value for highest single count).

noted adult bulls used heavily timbered areas at a higher frequency during both summer and winter than other elk.

On the East Boulder Plateau summer range, both yearling (spike) and adult (branch-antlered) bulls were observed with cow/calf groups. Two neck-banded yearling bulls were frequently observed with the cow/calf groups. A marked 2 year old bull, however, was not observed on the summer range.

Knapp (1973) recorded fewer bulls early in the summer than during the rut. In 1975 few bulls were observed during July and August. On September 5, 5 bulls and 62 cows were classified from a fixed-wing aircraft. On September 26, 10 bulls and 22 cows were counted from a helicopter. Of the 10, only 3 were listed as large, branch-antlered adults.

Discrete groups of bulls were rarely seen during the 4 years of observation. When encountered they were usually in close proximity to cow/calf groups.

The data were inconsistent in establishing the existence of separate bull groups on the summer range. No distinct bull summer range was located. It was possible the bulls used the timbered areas more than cows and were thus less visible.

The maximum number of bulls observed on the summer range since 1962 was 10. This high count was obtained during a helicopter flight on September 26, 1975. The average number observed during August and September was 5 for 1973, 1974 and 1975. The August (no flights were made in September) 1976 average was 2 bulls per flight. The largest number of branch-antlered adult bulls observed was: 3 in 1973, 4 in 1974, 3 in 1975 and 2 in 1976. These data suggest the bull segment of the East Boulder Plateau elk herd was young and small.

In 1974 and 1975 attempts were made to determine the total harvest of elk from the West Fork of the Stillwater segment of this herd. Early harvest data from the East Boulder Plateau were incomplete and no data were available from the Boulder River.

In both years 11 bulls were taken, 6 of which were yearlings (spikes). In 1974, one was a known 2 year old and 3 of the remaining 4 were classified as "raghorns" (2 year olds). Of the 5 older bulls taken in 1975, 3 were reported as having 6 points, one had 5 points and 1 had 2 points (reported as a forkhorn). Further inquiry revealed most of these bulls were probably in the raghorn category.

These harvest data suggest the bull population was larger than indicated by the summer counts. This implied bulls were using different areas on the summer range or different habitat types than the cows. These data further indicated the bull segment was composed mainly of young animals.

Food Habits

Knapp (1973) examined 12 elk feeding sites on the East Boulder Plateau in the summer and early fall of 1972. He found willow and sedges to be the main components of their diet. Grasses taken included tufted hairgrass, brome, rushes, and a trace of alpine timothy. The main forbs were fleabane, marsh marigold and bistort. Aggregate totals were: 35 percent grasses, 26 percent forbs and 39 percent shrubs.

Most of Knapp's (1973) observations were from Placer Basin where willow and sedges were major components of the flora. In subsequent years, elk were observed feeding in areas containing little or no willow. Although no feeding sites were examined in these areas, grasses and forbs were probably the dominant food items. Heavy use was noted on bluebell in the Trail Creek area.

Knight (1970) and Bohne (1974) reported wide variations in the summer diets of various Montana elk herds. In general, grasses and forbs received the heaviest use. The abundance and variety of grasses and forbs in all open areas of the East Boulder Plateau should rule out vegetation as a limiting factor to the distribution of this elk herd.

The lush grass and forb meadows on the slopes of Trail Creek probably contributed to the heavy elk use in this area. The main attraction in Placer Basin was the willow patches. Within the boundary of the exploratory mining activity numerous meadows and forest openings contained abundant forage. Altitudinal variations from 8500 feet to over 10,000 feet assured a continuous supply of succulent new growth. It would not appear the elk avoided this area due to a lack of forage. Further evidence of this was supplied when the Forest Service considered this area suitable for limited use by domestic sheep.

Elk Observations from Adjacent Summer Ranges

The East Boulder Plateau was only one of several elk summer ranges in the Beartooth and Absaroka Mountains. Occasional flights over and trips through these areas were conducted during the course of this study.

Numerous elk summered on the ridges and open meadows west of the main Boulder River (Gordon pers. comm. and Simmons pers. comm.). These elk interacted with those from the East Boulder Plateau on the Boulder River winter range. The extent or results of these interactions was unknown.

On March 10, 1975 three cow elk were tranquilized and neckbanded near Suzie Creek just south of Big Timber, Montana (Coop and Simmons 1975). One cow (red dot on white) was observed on July 18, 1975 at the head of Dry Fork Creek (a tributary of the East Boulder River) near Moccasin Lake. This represented a movement of approximately 10 air miles. She was accompanied by one large bull, one calf and seven other cows.

On July 23, 1975, 26 elk were observed around Moccasin Lake. The classification was: 1 large (branch-antlered) bull, 2 calves and 23 cows. All three neckbanded cows from Suzie Creek were observed. Flights later in the summer failed to locate this herd.

This herd was relocated in the same area on June 29, 1976. The classification was: 1 branch-antlered bull, 10 calves and 18 cows. One neckbanded cow (black dash on white) from Suzie Creek was observed. Picton (pers. comm.) counted 42 head around Moccasin Lake on July 6, 1976. He observed two neckbands (black dash on white and red and white diagonal) in the group. Subsequent flights failed to locate this herd.

The significance of this herd was its close proximity to the East Boulder Plateau summer range. Moccasin Lake was only 3 to 4 miles north of Picket Pin Mountain. The elk were apparently moving to a different range as the summer progressed. However, extensive surveys of Picket Pin Mountain and surrounding areas failed to locate them.

South of the East Boulder Plateau elk were scattered through the mountains north of Yellowstone Park. Lookout and Horseshoe Mountains supported large summer elk herds. On July 22, 1974, 16 bulls were sighted on the west side of Lookout Mountain and a large herd of cows and calves were on the divide between Slough Creek and Buffalo Forks Creek. On July 28, 1974, 15 bulls, 10 cows and 5 calves were observed scattered across Horseshoe Mountain. A group of 32 adults and 5 calves was seen on August 1, 1974 in Horseshoe Mountain basin.

Isolated observations included an adult (July 22, 1974) and a branch-antlered bull (August 16, 1974) near the head of the East Fork of the Boulder River. One spike bull was observed on August 1, 1974 north of Horseshoe Mountain on the west side of Timberline Mountain.

The appearance of a Yellowstone Park neckbanded elk on the East Boulder Plateau summer range indicated interactions between these herds occurred.

In July 1974 elk tracks were observed along the West Fork trail above the mouth of Trail Creek. The tracks were followed onto Lake Plateau and around Wounded Man Lake. Tracks were also noted crossing Jordan Pass. Hikers occasionally reported seeing elk in the Lake Plateau area. Extensive aerial surveys failed to locate elk in any of these areas.

East of the West Fork of the Stillwater River, a herd of between 50 and 70 elk wintered on the Mackay ranch between the East and West Rosebuds. No data were collected on these elk during the summer. They occasionally crossed the West Rosebud Creek and moved into the Fiddler Creek drainage. Observations along Fishtail Creek (just west of Fiddler Creek) suggested a resident population was establishing in this area. On May 7, 1974, 12 elk were observed just south of MacDonald Basin and on September 23, 1974 a spike bull and a cow were observed in the same area. Bulls have been reported as far west as Chrome Lake. It was doubtful whether any interactions occurred between this elk herd and those using the East Boulder Plateau summer range.

The East Boulder Plateau elk summer range was studied as a discrete unit. The data suggested this may not have been the case. This range was only one part of a complex system of summer and winter ranges used by the elk population of the Beartooth and Absaroka Mountains.

Summary

Elk apparently did not use the East Boulder Plateau summer range during the years of heavy use by domestic sheep. Elk first appeared on Breakneck Plateau following sharp reductions of sheep use in that area. As sheep numbers declined on the northern part of the range, exploratory mining activity increased.

The distribution of elk observations from the late 1960's to 1975 suggested the exploratory mining activity restricted elk to the southern portion of the range. Trail Creek, the North Fork of Hawley Creek and the adjoining plateau received the heaviest use. They frequently ranged north to Placer Basin but were rarely observed within the mining boundary.

In 1976 the Johns-Manville Corporation claim-staked Breakneck Plateau and the adjacent side drainages. Elk distribution prior to claim-staking was similar to what was observed in previous years. However, after this activity the elk shifted to the north. Use of the claim-staked areas was greatly reduced.

Neckbands provided data on the movements of individual elk. From 1973 through 1975 most relocations were from the southern end of the summer range. Movements of a few individuals indicated both bulls and cows ranged widely over the summer range. Prior to claim-staking in 1976, all relocations were from the southern end of the range. After claim-staking, all resightings were north of Breakneck Plateau.

The July and August average number of elk observed at one time in one general area (herd size) increased from 39 in 1973 to 45 in 1975. In 1976 the average declined to 18 elk per herd. These data supported the observation that following claim-staking, the elk were scattered in small groups throughout the summer range.

Cumulative yearly adult/calf ratios indicated no trend in production and/or survival since 1962. The average calf/100 adults ratio (1962-1976) was 32. Monthly totals and single flight high counts from 1973 through 1976 indicated production and/or survival may have increased slightly. For the last 2 years the July ratio was approximately 40 calves/100 adults.

Few bulls were observed on the summer range. Neither separate bull ranges nor herds were positively identified for this summer range. The harvest data suggested more bulls were present than were indicated by the summer counts. Apparently the male segment of the population was mainly composed of young (1-2 years old) animals.

Vegetation distribution and food habits data indicated forage was not limiting the elk to the southern portion of the range. The abundance and variety of forage species may, however, have attracted elk to some areas.

Data collected since 1973 indicated interactions had occurred between the East Boulder Plateau elk herd and other adjacent herds. Further study would be necessary to fully determine the extent of the interrelationships between these herds.

Winter Range

Location

The elk winter range lay along the north face of the Beartooth Mountains southwest of Nye, Montana. Castle Creek, the West Fork of the Stillwater River and the main Stillwater River formed the north and east boundaries. The south and west limits of the range were mainly governed by snow depth (Figure 4).

The West Fork of the Stillwater River divided the winter range in half. The eastern half, Horseman Flats, was characterized by a large, open, grassy bench with a gentle southeastern slope. Horseman Creek drained the flat. Along the eastern edge the flat dropped steeply, about 1000 feet, to the Stillwater River valley. To the southwest the flat merged with timbered mountain slopes. Sparsely timbered, rolling hills were found along the West Fork of the Stillwater River.

The western portion of the range lay between the West Fork of the Stillwater River and Meyer Mountain. Picket Pin Creek, Bear Pen Creek, Swamp Creek and Castle Creek drained this area. The physiography varied from steep-walled canyons and timbered benches to open, grassy slopes of all exposures. The main feature was a double-rimmed reef, with a saddle between the rims, to the east of Picket Pin Creek.

Vegetation

The Forest Service (South 1971) identified four ecosystems on the elk winter range: Douglas-fir, bunchgrass-forb, aspen, and rock outcrop-forest. For simplicity, the Douglas-fir and rock-outcrop forest ecosystems were combined.

Grassland

Basically the area was a grassland-forb association. However, patches of big sage were found along the eastern slope of Horseman Flats and on some east and northeast slopes in the Picket Pin region. Grasses which were abundant throughout the winter range included Idaho fescue, bluegrasses and bluebunch weatgrass. Along the eastern slope of Horseman Flats western wheatgrass, Junegrass, downy chess brome and timothy were also present.

On Horseman Flat and Picket Pin, *Hesperochloa kingi* was a major grass species. In addition, bearded wheatgrass, Junegrass, timothy and downy chess brome were found scattered throughout the area.

Various sedges occurred over the whole winter range and rushes were found in the wetter areas.

Forbs which contributed to the winter flora included fringed sage, phlox and pussytoes. Partially dried mats of mouse-ear chickweed and bedstraw were common. Dried forbs were leaves and heads of arrowleaf balsamroot, yarrow leaves, and the dried heads of other members of the COMPOSITAE family. In addition, patches of cudweed sagewort were found throughout the area.

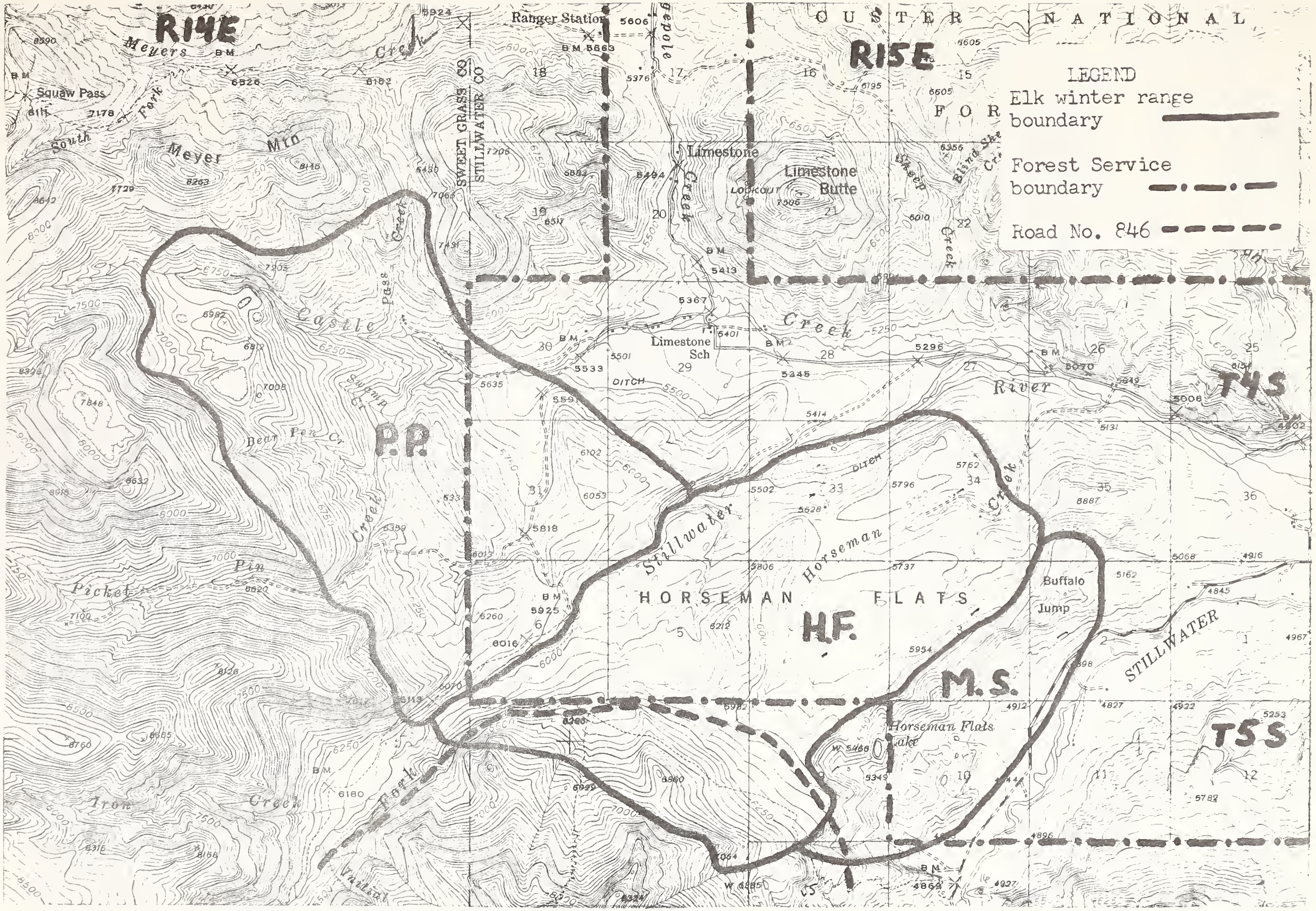


Figure 4. Boundaries of the three units of the elk winter range. (P.P. - Picket Pin unit, H. F. - Horseman Flats unit, M.S. - main Stillwater unit.)

The shrubs varied considerably between regions of the winter range. The eastern slopes of Horseman Flats had the most extensive shrub cover. Skunkbush sumac was the dominant species, with chokecherry, sagebrush, currant and rose occurring in lesser amounts.

Very few shrubs occurred over most of the open grasslands of Horseman Flats. Shrubby cinquefoil, horizontal juniper, ninebark and rose were found along the upper edge of the flats adjacent to the timber.

Sagebrush was common on some east and northeast facing slopes in the Picket Pin area. Rose was scattered throughout the area and horizontal juniper was common adjacent to the timber. Common juniper and ninebark were occasionally encountered near the timber.

Shrubs, in the openings along Castle, Swamp and Bear Pen Creeks, consisted mainly of sagebrush and shrubby cinquefoil. Small openings along these creeks contained shrubs characteristic of the open timber vegetation.

Douglas-fir and limber pine seedlings and trees frequently invaded the grassland.

Douglas-Fir

In most places the grassland ecosystem gradually merged with the forest ecosystem. Tree density and dominant species often varied. Douglas fir occurred in all areas, but varied from solid, mature stands to isolated trees and seedlings. Limber pine was dominant along the interface with the grassland ecosystem. The steeper mountain sides adjacent to the winter range were covered with extensive stands of lodgepole pine.

The understory varied with tree density and can be divided into two categories, open timber and dense timber.

The open timber areas were adjacent to the grassland and were predominantly limber pine and Douglas-fir. A few ponderosa pines were present. In most areas, Idaho fescue was the dominant grass with bluebunch wheatgrass, *Hesperochloa kingi*, and bluegrasses also commonly occurring. Rarer species included bearded wheatgrass and an unidentified brome. Sedges were also common. Forbs included arrowleaf balsamroot, pussytoes, phlox and fringed sage.

On Horseman Flats the dominant shrubs were horizontal juniper and ninebark. Also present were shrubby cinquefoil, rose, common juniper, buffaloberry and bearberry. In the Picket Pin area, ninebark was the main shrub. Additional shrubs were horizontal juniper, common juniper, sagebrush and rose.

The dense timber, lodgepole pine or Douglas-fir, generally contained little understory. Grasses and sedges were scarce. Bluegrasses were the most common grasses, with Idaho fescue and bluebunch wheatgrass occurring rarely. Forbs were almost nonexistent. Shrubs were fairly abundant in the understory and the dominant shrub was ninebark. In the lodgepole pine, snowberry and buffaloberry were also present. Under the Douglas-fir canopy, rose and sagebrush were occasionally observed.

The densely timbered slopes of Bear Pen and Castle creeks were composed of Douglas-fir and spruce. The understory was predominantly ninebark and snowberry.

Aspen

Aspen groves were found on the eastern slopes of Horseman Flats and along the upper edge of the flats at the grassland-forest interface. Small patches were also found in the Castle, Swamp and Bear Pen creeks area. The dominant overstory vegetation was quaking aspen. Douglas-fir and limber pine were scattered throughout the groves. Rocky Mountain juniper occurred rarely in the groves on the eastern slope.

The shrubs were abundant and varied. Common shrubs on the eastern slope included rose, snowberry, gooseberry, raspberry, chokecherry, willow and red osier dogwood. Less common species were water birch, horizontal juniper and skunkbush sumac.

The dominant shrubs on Horseman Flats and along Castle Creek were snowberry and ninebark. Other shrubs were gooseberry, rose, cinquefoil, creeping juniper, common juniper, buffaloberry and raspberry.

The main grasses in all aspen patches were bluegrasses. On the eastern slope, western wheatgrass and timothy were also present. Along the upper edge of Horseman Flats bluebunch wheatgrass, Idaho fescue and sedges contributed to the ground cover.

Forbs were of minor importance to the winter flora of the aspen patches.

Climate

Snowfall was the main climatic factor of the elk winter range. Starting in 1971, the snowpack was measured at monthly intervals on, and adjacent to, the winter range. The lower Picket Pin snowcourse (Table 9) was representative of the winter range. The middle Picket Pin course (Table 10) at 7250 feet elevation, recorded the snowpack above the winter range. In addition, total monthly precipitation was measured at the lower snowcourse (Table 11).

Factors influencing snow accumulation were wind and exposure. The east facing slopes of Horseman Flats and the south facing slopes of Picket Pin generally had the least snow. Strong, warm Chinook winds would frequently remove most of the snow from Horseman Flats, and to a lesser degree, from the Picket Pin area. Tree line was the upper limit of the influence of these winds.

The lower snowcourse was at the timber edge sheltered from the winds and had a slight northeast exposure. The middle course was in a small timber opening adjacent to the Picket Pin Mountain road.

The 5-year average monthly (November 1 through May 1) snow depth on the lower course was 8 inches. On the middle course the average through June 1 was 27 inches. The 4-year average total precipitation from October

Table 9. Monthly snow depth in inches from the lower Picket Pin snowcourse (6200 feet elevation).

Month	1971-72	1972-73	1973-74	1974-75	1975-76	Average
November	-1/	0	0	15	5	5
December	72/	2	1	6	11	5
January	-	11	6	7	10	9
February	8	8	2	15	10	9
March	0	6	0	13	19	8
April	0	16	0	24	13	11
May	0	21	0	18	9	10
Average	3	9	1	14	11	8

1/ No data.
2/ Each value was the average of 10 stops read at the first of each month.

Table 10. Monthly snow depth in inches from the middle Picket Pin snowcourse (7250 feet elevation).

Month	1971-72	1972-73	1973-74	1974-75	1975-76	Average
November	-1/	2	0	26	8	9
December	182/	8	7	15	26	15
January	25	19	15	26	32	23
February	48	23	19	44	42	35
March	50	21	22	50	58	40
April	28	40	31	65	55	44
May 1	0	53	9	63	48	35
May 15	0	29	0	54	10	19
June	-	-	0	35	0	12
Average	24	24	18	42	31	27

1/ No data.
2/ Each value was the average of 10 stops read at the first of each month (except May 15).

Table 11. Total monthly precipitation (in inches) from the lower Picket Pin precipitation gage (6200 feet elevation).

Month	1972-73	1973-74	1974-75	1975-76	Average
October	1.95	0.19	4.09	3.70	2.48
November	0.59	2.93	1.00	2.93	1.86
December	2.00	0.58	0.59	1.36	1.13
January	0.75	0.78	2.53	1.37	1.36
February	0.39	0.59	0.98	1.75	0.93
March	2.73	2.73	2.53	1.17	2.29
April	5.07	3.31	2.93	6.24	4.39
Total	13.48	11.11	14.65	18.52	14.44

through April was 14.44 inches. This compared with 23.58 inches of precipitation collected during the same time period at 8500 feet elevation.

Records from the snowcourses indicated accumulation was lightest in 1973-74 and heaviest in 1974-75. The precipitation data confirmed 1973-74 was a dry year, but total precipitation in 1975-76 was considerably higher than 1974-75. The absence of the chinook winds partially accounted for the increased snow depths in 1974-75. The distribution of snowfall from December through March may also have had an effect. In 1975-76 precipitation was evenly distributed while in 1974-75 January and March received much heavier snowfall than December and February. Spring storms (March and April) accounted for the bulk of the precipitation in 1972-73.

In the low snow years of 1971-72 and 1973-74, no snow was measured on the lower course after February 1. Snowfall after this date melted rapidly and did not accumulate. By May 15 of each year the lower course was void of snow.

History of Land Use

Domestic Livestock Grazing

The U. S. Forest Service grazing files revealed that from 1920-1948, Castle Creek was a domestic sheep allotment. Sheep numbers were reduced from 1400 in 1922 to 1000 in 1926 and to 900 in 1940. The season length was also reduced from 3 months in the 1920's to 2 months in 1938. Range reports, beginning in 1942, indicated the range was overstocked and abused. In 1948 the sheep permit was canceled and in 1949 Castle Creek was added to the Picket Pin cattle and horse allotment.

The Picket Pin allotment may have been used by sheep in the early 1920's. In 1924 the allotment was converted to cattle and horses. Fifty head were allowed for 4 months until 1928 when it was increased to 60 head. In 1935

the South Pass Creek sheep allotment was added, the carrying capacity was increased to 165 (140 cows, 25 horses) and the season was extended to 5 months for the horses. Through the 1940's the number permitted varied from 140 to 155. In 1949 the Castle Creek sheep allotment was added to Picket Pin and in 1950 the 25 horse permit was converted to cattle. From 1950 to the present, the combined allotment supported 160 head of cattle for 4 months each year (7/1 - 10/31).

The Forest Service portion of Horseman Flats has continuously been allotted to cattle grazing since the early 1920's. In 1922, 169 head used this range for 4 months (6/1-9/30). The number declined to 130 in 1928, 125 in 1933 and to 105 in 1940. Temporary permits varied the numbers from year to year. The grazing season was set back a month in 1947 (7/1-10/31) due to larkspur. The season was shortened to 3 months in 1954 and to 2 months in 1964. At present, 105 head of cattle used this allotment for 2 months (7/10-9/10).

Summer homes on the main Stillwater portion of the elk winter range.

Summer Homes

The beautiful mountainous setting, with abundant running water, led to a rash of summer home subdivisions in the Stillwater valley. Of prime importance to the elk winter range was the approximately 500 - acre Cathedral Mountain subdivision on the eastern slopes of Horseman Flats. The area was split into 210 cabin sites. However, by 1976 only 11 cabins and 1 condominium had been constructed. Winter activities were limited to a few weekend visits and regular snow removal from the road.

Mining Activity

The Stillwater valley had a long history of mineral exploration and development. The Mouat property on the main Stillwater River was developed for chromite production in 1943 and again from 1952 to 1961.

The road across Horseman Flats (No. 846) was built in 1942 to service mining claims along the West Fork of the Stillwater River. The Anaconda Company core drilled the southern end of Horseman Flats in the 1960's and an abandoned limestone quarry was located in the southeast corner of the flats.

In 1974 the Johns-Manville Corporation, exploring for platinum group metals, located a mineralized zonal outcrop along the West Fork of the Stillwater River. The find was of significant magnitude to warrant the construction of an exploration adit. The adit, a 3,000-foot tunnel along the strike of the mineralized zone, was expected to produce a bulk ore sample of about 1000 cubic yards. Support facilities were set up in the Initial Creek campground and the adit was started in December 1974.

In early 1975 the company purchased the approximately 1500 acre Picket Pin ranch. The ranch, bordering the Custer National Forest, was approximately four miles downstream from the adit.

Adit construction operated continuously through the winter of 1974-75. In addition, a bridge was constructed across the West Fork of the Stillwater River in late winter of 1975. The access road crossing Horseman Flat was kept open all winter. A locked gate prevented travel by the general public.

Adit construction continued into the winter of 1975-76. Work in the adit ceased for approximately two weeks during the Christmas-New Year period. It was again closed down in February 1976 when a large volume

of water was encountered. It remained closed through the summer of 1976. Even during the closed periods, maintenance travel necessitated snow removal from the access road across Horseman Flats. The road was posted but the gate was not locked in 1975-76.

The Picket Pin ranch was leased back to one of the original owners. Activities by the mining company were limited to construction of a short spur road and core drilling of the proposed dam site.

In 1975 the Johns-Manville Corporation released proposed plans for future development. The plans called for a mine near the present adit, a haul road connecting the mine and the Picket Pin ranch and a concentrator and settling ponds on the ranch. A smelter may also be constructed on the ranch property.

Elk History

Large piles of antlers, picked up on Horseman Flats by early settlers, suggested elk were abundant in the early and mid-1800's. Unfortunately very little data were available on the early history of this elk herd. One long-time resident reported seeing a dead elk on Horseman Flats in 1911 and elk sign in a meadow above the flats in 1914 and 1915 (D. Whited pers. comm.).

In the winters of 1935-36 and 1936-37, the Forest Service conducted extensive game counts in the area (Cooney 1936 and 1937). No mention was made of elk wintering on Horseman Flats or in the immediate vicinity. A local resident, however, recalled a small herd used this area in the late 1930's and early 1940's (P. Winge pers. comm.).

In 1946, one bull was observed near the Mouat Mine (Couey 1946). Four bulls were seen near Bear Pen Creek in 1953 and 17 elk were observed on Horseman Flats in 1955. In the same year, 19 head were counted along the West Fork near Initial Creek (G. McKittrick pers. comm.).

A Forest Service report stated, "elk in the West Fork of the Stillwater probably move out in midwinter and are part of the Deer Creek herd. They used the Breakneck Park area earlier in the winter, but were gone by February 8, 1955."

The data suggest a small group of elk intermittently used the Horseman Flats-Picket Pin Creek winter range until the late 1960's when the herd suddenly increased.

In the spring of 1971, 35 elk were censused on Horseman Flats (Gordon and Coop 1972). The number observed increased to 43 in 1971-72 and to 50 in 1972-73 (Stoneberg 1973). In 1973-74, the high census following the hunting season when approximately 15 bulls were harvested, was 62 head. Considerable haystack damage was reported in the Picket Pin area during the winter of 1973-74. In 1974-75, 56 elk were observed on the winter range following the removal of at least 18 head during the hunting season. The high count in 1975-76 was 67 head after a harvest of at least 12.

Hunting Season

Prior to 1973, hunting was limited to antlered bulls during the regular season. In 1973, 10 either sex permits were issued for one week prior to the general season. No elk from the Horseman Flats-Picket Pin winter range were taken with these permits. By questioning residents and hunters, the regular season harvest in 1973 was estimated at 15 bulls.

In an attempt to reduce the herd, 50 either sex permits were issued for the 1974 season. At least 18 elk were known to have been harvested from the winter range in 1974 (Table 12). Fifty either sex permits were also issued in 1975. The minimum known harvest from the winter range was 12 elk.

Table 12. Age and sex of known elk harvest from the Horseman Flats-Picket Pin winter range, 1974 and 1975.

	1974	1975
Adult Male	3	4
Adult Female	4	2
Yearling Male	5	5
Yearling Female	4	0
Calf Male	1	0
Calf Female	1	1
Total	18	12
Total Males	9	9
Total Females	9	3

Population Data

The post hunting season censuses on the Horseman Flat-Picket Pin winter range increased from 35 elk in 1970-71 to 67 elk in 1975-76. When known harvest figures were added, the totals were 77, 74 and 79 for 1973-74, 1974-75, and 1975-76 respectively.

Age classifications (Table 13) indicated calf survival through early winter was high. A slight decline was noted from 43 calves/100 adults in 1971-72 to 40 calves/100 adults in 1975-76.

Table 13. Age and sex classifications for elk using the Horseman Flats-Picket Pin winter range, 1971-72 - 1975-76.

	Bulls	Cows	Adults	Calves	Uncl.	Total	Calves/ 100 Ad.	Calves/ 100 Cows
1970-71 1/	1	29	30	5	0	35	17	17
1971-72 2/	1	29	30	13	0	43	43	45
1972-73	8	27	35	15	0	50	43	55
1973-74	3	19	22	13	27	62	59	68
1974-75	1	36	37	15	4	56	41	42
1975-76	3	40	43	17	7	67	40	43

1/ From Gordon and Coop 1972.

2/ Largest number classified on one day.

Winter age ratios were generally higher than those from the summer range. This was apparently due to the differential age ratio of the harvest. When known harvest figures were added to the winter classifications, the resulting age ratios were similar to those obtained from the summer range.

A yearly harvest of between 15 and 20 elk would be necessary to limit the wintering elk population to the desired 50-60 animals.

In 1972-73, eight bulls were observed on the winter range for a ratio of 30 bulls/100 cows. During the next three winters the maximum number of bulls recorded was 3. In 1974-75 and 1975-76 the ratio was 3 and 8 bulls/100 cows respectively. The ratios increased to 25 bulls/100 cows in 1974-75 and to 30 bulls/100 cows in 1975-76 when the known antlered bull harvests were added. Apparently most bulls coming onto the winter range during the past three years were being harvested.

All bulls observed on the winter range from 1973-74 through 1975-76 were yearlings (spikes). Five yearling males were harvested in both 1974 and 1975. In addition, most adult bulls in the harvest were in the 'raghorn' (2 years old) category. These data supported the findings from the summer range that the bull segment of this population was small and young.

Distribution of Elk on Winter Range

The Stillwater elk winter range was divided into three sub units--Picket Pin, Horseman Flats and main Stillwater. The West Fork of the Stillwater River divided the Picket Pin and Horseman Flats units. The main Stillwater unit included the east-facing slopes of Horseman Flats west of the Stillwater River (Figure 4).

Within the Picket Pin unit the main area of elk use lay between Picket Pin Creek and the West Fork, adjacent to the Forest Service boundary. Swamp Creek and Bear Pen Creek were also important to the elk.

On Horseman Flats, the key area was the timber edge above the road, including Rabbit Gulch and Horsehead Draw. Along the main Stillwater, the Cathedral Mountain cabins property, in the vicinity of Horseman Flats Lake, and the adjacent ranch property to the north, were the key elk areas.

Table 14 compares elk use of the units from 1971-72 to 1975-76. In 1971-72, all observations were on Horseman Flats. However, very little census work was conducted on the other units. In 1972-73, the area was covered more extensively and the observations were evenly divided between Horseman Flats and Picket Pin. In 1973-74, 1974-75 and 1975-76, the units were periodically censused in an effort to determine distribution and movements on the winter range.

Table 14. Percentage distribution of elk observations on units of the winter range.1/

Unit	1971-72 Percent	1972-73 Percent	1973-74 Percent	1974-75 3/ Percent	1975-76 Percent
Horseman Flats	100	45	48	4	9
Main Stillwater	0	0	10	79	52
Picket Pin	0	55	42	17	39
Total	155(5)2/	207(9)	683(51)	2484(84)	948(44)

1/ Aerial and ground observations combined.

2/ Total number of elk observed (number of observations).

3/ Included sightings by Stewart (pers. comm.).

The elk observations were equally divided between Picket Pin and Horseman Flats in 1973-74. Relatively little use was recorded on the main Stillwater unit. In 1974-75 the situation was reversed. The majority of the observations were on the main Stillwater unit. The Picket Pin unit received moderate use and very few elk were observed on Horseman Flats. In 1975-76 elk were mostly observed on the main Stillwater and Picket Pin units. Horseman Flats again received little use.

The data in Table 15 reflected the monthly distribution of elk during the winters of 1973-74, 1974-75, and 1975-76. Since access, effort, and observability varied between the areas, these data indicated the presence or absence of elk in a unit rather than the actual proportion of use.

In 1973-74 elk used the Horseman Flats and Picket Pin units throughout the winter. The operation of the elk trap on Horseman Flats may have influenced their distribution. However, elk were observed on Horseman Flats in each month from January through June. In April and May 1974, a portion of the herd was observed using the main Stillwater unit. Local residents reported the main Stillwater unit had been used in the spring in previous years.

The elk were widely dispersed on the winter range during the 1974 hunting season. They were reported from Pass Creek, north of Picket Pin across Horseman Flats to Mountain View Creek.

Immediately following the hunting season, most of the elk were observed on the Picket Pin unit. They remained on this unit until late January 1975, then moved to Horseman Flats. They stayed on the flats for only 3 or 4 days, then moved to the main Stillwater unit where they stayed until mid-May. Only one group of 10 elk was known to have ventured back onto Horseman Flats. They soon returned to the main Stillwater unit. In late May the elk dispersed across the winter range as they broke up into calving groups.

Following the 1975 hunting season the elk were evenly divided between the Picket Pin and the main Stillwater units. They apparently remained split into two separate herds throughout the winter. The main Stillwater segment was occasionally observed on Horseman Flats.

The Picket Pin segment did not drift eastward to Horseman Flats when disturbed by snowmobiles or other traffic as they had in the past. Rather they moved northwest across Castle Creek to the Pass Creek slopes.

Elk distribution on the winter range shifted somewhat during the course of this study. In particular, they avoided Horseman Flats in 1974-75 and 1975-76.

Trapping and Marking

A panel elk trap was set up in Rabbit Gulch on Horseman Flats. The trap was operated during the winters of 1972-73 and 1973-74. Second cutting alfalfa hay was used for bait.

Table 15. Percent of monthly elk observations on each of the three units of the Horseman Flats - Picket Pin winter range, 1973-74 - 1974-75.1/

	Picket Pin			Horseman Flat			Main Stillwater		
	1973-74	1974-75	1975-76	1973-74	1974-75	1975-76	1973-74	1974-75	1975-76
December	100	98	55	-	2	-	-	-	45
January	9	67	24	91	33	25	-	-	51
February	46	-	25	54	6	9	-	94	66
March	84	-	50	16	-	-	-	100	50
April	21	-	45	27	-	-	52	100	55
May	43	7	50	42	-	29	15	93	21
June	23	71	25	77	28	75	-	1	-

1/ Aerial and ground observations combined.

Six elk were trapped and marked in 1972-73. All received a numbered metal tag in the right ear and a numbered, colored plastic, pendant tag in the left ear. Four of the elk were neckbanded with six inch wide, webbing-backed, color coded (Saflag) bands.

In 1973-74, eleven elk were marked. All were ear tagged as in the previous year. Eight received six inch wide, webbing backed neck bands. Two calves were banded with three inch wide numbered strips of saflag (no backing) and one calf was ear tagged only. Four of the neck bands were fitted with radio transmitters operating in the 151 MHz range. The transmitters, however, were overpowered by an answering service signal from Billings, before the elk left the winter range. The fate of the marked elk was listed in Table 16. Nine of the seventeen were known casualties of the hunting seasons. This included one unbanded cow that had lost the metal ear tag and the numbered portion of the plastic tag. All males were harvested within two years of marking. The data suggested hunting pressure was extremely heavy on this segment of the population.

Five neck banded cows were observed during the spring of 1976. It was noted the saflag on some of the bands had worn off making identification extremely difficult.

Movements of Elk on Winter Range

The neckbanded animals provided data on the movements of individual elk on the winter range. They also proved elk returned to the same winter range each year.

Four elk were neckbanded in January and February 1973 (Stoneberg 1973). Three of the bands were observed on the Picket Pin unit in March. The fourth, a bull, was reobserved on Horseman Flats in mid-June. Only one neckbanded (S2295) elk survived to the following winter.

Ten more elk were neckbanded in January, February and April 1974 (Stoneberg 1974). One was never reobserved following banding. Two of the elk marked in January were fitted with radio transmitters. Radio locations and occasional sightings indicated all neckbands were on Horseman Flats through January and part of February. Following the capture of two elk in February, all neckbands, except the one from the previous year, moved to the Picket Pin unit. They remained in these areas through March.

In April 1974, four more elk were banded. Two of these immediately moved to the Stillwater unit where they were joined by the band from Horseman Flats and two bands from Picket Pin. Three remained on the Picket Pin unit.

Considerable movement was noted in May and early June.

Following the 1974 hunting season, all surviving neckbanded animals (six) were on the Picket Pin unit. In late January 1975 they moved,

Table 16. Known fates of elk (through summer 1976) banded on Horseman Flats in 1972-73 and 1973-74.

Elk No.[1/]	Date Banded	Sex	Age	Fate
S2297	1/31/73	M	.5	Shot 11/5/73
S2295	1/31/73	F	1.5	Present 1976
S2497	2/8/73	F	Ad.	Lost Neckband
S2499	2/8/73	F	Ad.	(Eartagged only)
S3598	2/8/73	M	.5	Shot 11/19/74
S3599	2/8/73	F	Ad.	Lost Neckband
S3544	1/8/74	F	Ad.	Shot 11/2/74
S3545	1/8/74	F	.5	Present 1976
S3546	1/8/74	F	.5	Present 1976
S3550	1/8/74	M	.5	Shot 11/17/74
S3549	1/8/74	M	.5	Shot 10/20/75
164	2/22/74	F	1.5	Present 1976
165	2/22/74	M	.5	Unknown
174	4/9/74	F	Ad.	Present 1976
S3548	4/9/74	F	.5	Shot 11/6/74
172	4/9/74	M	1.5	Shot 11/1/74
173	4/9/74	M	.5	Shot 11/3/74

1/ Metal ear tag number.

Aerial view of Johns-Manville exploration adit (tunnel) along the West Fork of the Stillwater River.

first to Horseman Flats and then to the main Stillwater. They remained on the main Stillwater unit through mid-May. On May 27 one band was on the main Stillwater and five were on the Picket Pin unit. By mid-June the one remaining band was also on the Picket Pin unit.

In 1975-76, five neckbanded cows were observed on the winter range. Four spent the entire winter on the Picket Pin unit and the fifth on the main Stillwater unit. The latter was observed once on Horseman Flats. Twice during the winter the Picket Pin bands were observed on the Pass Creek slopes west of Castle Creek. Picton's (pers.comm.) data confirmed this distribution.

Picton (pers. comm.) recorded some movement in May 1976. One band from Picket Pin moved to the Stillwater unit and the one from the Stillwater moved to Picket Pin. The other three bands stayed on the Picket Pin unit.

The distribution of neckbands during the winter months (Table 17) generally reflected the patterns of the total herd (Table 14). The main exception was 1975-76 when more neckbands were on the Picket Pin unit than the main Stillwater unit. Total elk numbers, however, were about equal on the two units.

Neckband observations on Horseman Flats declined drastically between 1973-74 and 1974-75. In 1975-76 only one band was observed on the flats. Since these elk had used this area in the past this may have indicated extrinsic rather than intrinsic factors were influencing their movements and distribution on the winter range.

Food Habits

The food habits of elk using the Stillwater winter range were studied in 1974-75 (Table 18). Although an attempt was made to collect data from each area of the winter range, the majority came from the Stillwater unit. This was due to the differential use of the units by the elk. This also resulted in a temporal variation in the data. The Picket Pin sites were examined in December and January. The data from Horseman Flats were collected in late January and those from the Stillwater unit from February to April.

Grasses were the dominant food item of the wintering elk. In the Picket Pin area Idaho fescue was heavily used, while in the other two areas bluegrasses were preferred. Fescue was abundant on the drier open slopes, and bluegrasses predominated in the swales and aspen patches. *Hesperochloa kingi* was a major species on Picket Pin and Horseman Flats but was replaced by western wheatgrass on the Stillwater unit. Bluebunch wheatgrass was used to some extent in all areas. However, use was mainly on the dried heads and it was often difficult to determine current from past use. Junegrass was not abundant but received some use when encountered.

Forbs were more abundant on the drier fescue slopes. Fringed sage and phlox were the main species taken. The dried heads of various composites were used, but again, current use was difficult to determine. Horsetail, found along the edge of a pond, received moderate use.

Table 17. Distribution by unit of neckband relocations from December through April 1973-1976.[1/]

Elk No.[2/]	Picket Pin 1973-74	Picket Pin 1974-75	Picket Pin 1975-76	Horseman Flats 1973-74	Horseman Flats 1974-75	Horseman Flats 1975-76	Main Stillwater 1973-74	Main Stillwater 1974-75	Main Stillwater 1975-76
S2295	-	6	11	6	1	-	2	13	-
S3544	4	-	-	16	-	-	2	-	-
S3545	4	6	8	3	1	-	-	11	-
S3546	6	5	5	4	1	-	-	10	-
S3549	6	7	-	11	2	-	2	12	-
164	7	5	9	1	1	-	-	14	-
174	-	5	-	1	1	1	-	11	9
Total	27	34	33	42	7	1	6	71	9
Percent[3/]	36	30	77	56	6	2	8	64	21

1/ Aerial and ground observations combined. Includes visual and radio locations.

2/ Metal ear tag number

3/ Percent of winter total.

Table 18. Percentage of items in the winter and early spring diet of elk on the Horseman Flats-Picket Pin winter range as determined by examination of 13 feeding sites in 1974-75.

Species	Picket Pin 4 Sites 1105	H'smn Flats 1 Site 773	Stillwater (Bunchgrass) 6 Sites 7044: Poa 5 Sites 6262	Stillwater (Bunchgrass) 6 Sites 7044: Total	Stillwater (Bunchgrass) 6 Sites 7044: FEID 1 Site 782	Stillwater (Aspen) 2 Sites 1277	Total 13 Sites 10,199
GRASS & GRASSLIKE PLANTS							
Poa spp.	10.2	67.5	81.5	72.8	2.7	30.5	60.3
Festuca idahoensis	20.1	0.8	-	2.3	19.2	-	3.8
Hesperochloa kingi	16.6	29.6	-	-	-	-	4.0
Agropyron spicatum	12.8	0.5	0.3	1.9	14.8	0.5	2.8
Agropyron smithii	-	-	5.8	5.1	-	-	3.5
Koeleria cristata	5.2	0.4	2.2	5.2	28.5	-	4.1
Phleum pratense	2.1	-	0.4	0.3	-	-	0.5
Bromus tectorum	-	-	0.4	0.4	-	-	0.3
Unidentified grass	0.4	-	-	-	-	-	Tr
Carex spp.	-	-	Tr	0.6	4.7	-	0.4
TOTAL GRASS	67.4	98.8	90.6	88.6	69.9	31.0	79.7
FORBS							
COMPOSITAE	0.1	0.5	0.1	0.1	-	-	0.1
Artemisia frigida	13.8	-	3.2	5.6	24.5	0.4	5.4
Phlox hoodii	16.0	-	Tr	0.6	5.5	-	2.2
Balsamorhiza sagittata	1.6	-	-	-	-	-	0.2
Artemisia ludoviciana	0.2	-	1.0	0.9	-	-	0.6
Achillea millefolium	0.4	-	-	-	-	-	Tr
Equisetum spp.	-	-	4.3	3.8	-	-	2.6
Unidentified forbs	0.2	-	-	-	-	-	Tr
TOTAL FORBS	32.3	0.5	8.6	11.0	30.0	0.4	11.1
SHRUBS							
Artemisia tridentata	0.3	-	-	-	-	19.0	2.4
Rosa spp.	-	0.7	-	-	-	-	Tr
Rhus trilobata	-	-	-	-	-	13.2	1.6
Salix spp.	-	-	-	-	-	13.9	1.7
Prunus virginianus	-	-	0.4	0.4	-	7.4	1.2
Cornus stolonifera	-	-	-	-	-	8.1	1.0
Populus tremuloides	-	-	-	-	-	7.0	0.9
TOTAL SHRUBS	0.3	0.7	0.4	0.4	-	68.6	8.8

Two feeding sites were located within aspen groves and recorded considerable use on browse. The species used included big sage, skunk-bush, willow, red osier dogwood, chokecherry and quaking aspen. Although, as these sites indicated, browse was consumed, it did not appear to form a major portion of the overall elk winter diet.

A few instances were also noted where elk had eaten the needles of Douglas-fir and lodgepole pine, but this use was not recorded in any of the feeding sites.

Elk vs. Cattle

Competition between cattle and elk for available forage existed on the winter range. Two problem areas were around the water trough on Horseman Flats, and along the Forest Service boundary fence in the Picket Pin area. Both problems were due to cattle distribution.

The only available water on Horseman Flats was from a trough at the timber edge adjacent to aspen groves. The cattle stayed close to the water and severely overused this portion of the range. Efforts to disperse them through riding and salting resulted in extensive trail systems radiating from the water trough. Some areas on the allotment were only lightly utilized.

The grassy slopes and aspen patches adjacent to the water trough were also heavily used by elk. The obvious solution would be to pipe the water down hill away from the timber edge. In particular, water troughs should be established in the open timber on the southeast corner of the flats. This area has received little use by cattle or elk in the past.

A further remedy would be to divide the Forest Service allotment with a drift fence running north and south. Elk primarily used two draws along the upper edge of the flats, Horsehead Draw immediately east of the water trough and Rabbit Gulch a short distance west of the trough. Both were grassy slopes with east and southwest exposures. The drift fence would include one of these draws in each pasture. By rotating the use, one pasture would be allowed to recover prior to the arrival of elk in the fall.

The drift fence, along with better water dispersal, would probably eliminate most cattle/elk conflicts on Horseman Flats.

The conflict in the Picket Pin area resulted from cattle congregating along the Forest Service boundary fence in the fall. The last area used by the cattle was the prime elk winter range. This resulted in the summers growth being removed with little chance for second growth prior to the arrival of the elk.

The south and east facing grassy slopes in the Picket Pin drainage along the Forest Service boundary should be managed as important elk winter range. Reconstruction of the drift fence part way up the Picket Pin drainage would greatly reduce the conflict between cattle and elk. Cattle could

graze the elk winter range early, then be fenced off for the rest of the season. The range would have a chance to recover prior to the arrival of the elk.

The Forest Service grazing policy should be changed to include more funds for allotment improvements. In many areas wildlife-livestock conflicts could be reduced or eliminated by fence construction and proper water distribution.

In some instances the elk may have benefited from heavy use by cattle. The green, succulent, second growth of the grasses were preferred by the elk. The grazing both stimulated and exposed this growth.

As snow depths increased, the forage on the heavily grazed areas became unavailable and the elk moved to the more lightly grazed areas. The taller, denser, dried grass clumps broke up the snowpack and provided easier foraging. It was noticed the green leaves at the base of the clumps were preferred over the dried summer growth.

The elk winter range encompassed both Forest Service and private lands. Any management programs for the Forest Service lands must include a consideration of the grazing practices on the private land. The present arrangement of cattle grazing the national forest in the summer and elk using the private land in the winter appeared to be beneficial to both. There was no evidence of malnutrition in this elk herd. To the contrary, most of the animals appeared in excellent shape at the end of the winter. Apparently there was adequate forage on the winter range to sustain the present size elk herd.

Elk vs. Summer Homes

Summer home construction in the Stillwater valley posed a potential threat to the elk winter range. Of immediate concern was the 500 acre Cathedral Mountain subdivision on the east facing slope of the Stillwater River. This property was heavily used by elk in 1974-75 and 1975-76.

The importance of the main Stillwater unit to the wintering elk herd was emphasized when the Horseman Flats unit was avoided. The 1 to 2 square mile area supported the entire wintering herd for four months in 1974-75 and half of the herd for at least five months in 1975-76. Any disturbance, therefore may drastically impact this herd.

To date few cabins have been constructed and most activities were limited to the summer months. In 1974-75 a part-time caretaker patrolled the area and plowed roads. A full-time caretaker lived on the property in 1975-76. Although quantitative data were lacking, observations indicated the elk moved to the timbered fringes of the subdivision and north to the adjacent ranch property when disturbed. Winter activities will probably greatly increase if the potential density of one cabin per two acres is realized.

The marginal nature of the Forest Service portion of the winter range emphasized the importance of the adjacent private land. Primarily this involved portions of three ranches. One was purchased by Johns-Manville Corp., and faced extensive development. Subdivisions on key portions of either of the other two would critically reduce the carrying capacity of the range.

Elk vs. Mining

In 1974 Johns-Manville Corp. announced plans to construct an exploration adit (tunnel) along the West Fork of the Stillwater River. A camp was established in the Initial Creek campground and Forest Service road No. 846 across Horseman Flats was used for access. Adit construction began in December 1974.

Observations and neckband relocations prior to 1974-75 indicated Horseman Flats was a major component of the elk winter range. However, in 1974-75 very little use of the flats was recorded. (Tables 15 and 17). Increased traffic on road No. 846 probably caused the shift in use patterns.

Prior to 1974, the Horseman Flats road drifted shut in early winter. Vehicle traffic was limited to occasional trips by local residents during periods of mild weather. When development plans were announced by the mining company, restrictions were suggested for vehicle use of the road. A locked gate prevented access by the general public. The recommended restriction of travel time, from one half hour after sunrise to one half hour before sunset, was only lightly adhered to.

Beginning in December 1974, the mining company removed snow and maintained the road in a drivable condition. The snow removal presented two problems to the elk. First, the operation of the machinery, particularly the caterpillar tractors, probably disturbed the elk more than conventional vehicles. Secondly, the snow was piled on the leeward side of the road. By mid-winter a formidable barrier to elk travel was established.

Table 9 confirmed the general observation that snowpacks were heavier than normal in 1974-75. However, snowdepths rarely exceeded two feet and domestic horses wintered without supplemental feed on the adjacent privately owned portions of the flats. In addition, other segments of the winter range experienced similar snow conditions. Therefore, snow depths alone were probably not the cause of the avoidance of Horseman Flats by the elk.

In previous years the elk were observed bedding in the timber above the road and venturing onto the exposed slopes and open flats for feeding. During periods of deep snow they crossed the road and grazed across the private lands. The traffic on the road probably disrupted this pattern and forced the elk to winter elsewhere.

The exploration activity continued into the winter of 1975-76. Following the hunting season, the elk were split into two groups: one on the main Stillwater unit and one on the Picket Pin unit. Elk again avoided the Horseman Flats portion of the winter range. The Lower Picket Pin snow course records indicated 1975-76 snowpacks were slightly higher than the 5 year average but were lower than the previous year. In addition, frequent chinook winds reduced snow accumulation in 1975-76.

Elk or tracks were occasionally sighted on Horseman Flats in December 1975 and January 1976. In mid-January the herd from the main Stillwater unit spent approximately one week on the flats. They remained above the road during the entire stay. They were next sighted on the flats in mid-May.

Vehicle traffic across Horseman Flats was reduced in 1975-76 due to the completion of construction projects. The adit was also closed for 1 to 2 weeks during the Christmas-New Year periods. By late February the adit was closed for the rest of the winter. The road supported maintenance traffic and regular snow removal during the closures.

The behavior of the elk in January supported earlier findings. They could tolerate the mine traffic if they did not have to cross the road. Observations after February indicated a minimum amount of traffic was sufficient to keep elk away from the Horseman Flats unit.

Activities associated with the adit construction afforded a preview of the potential disturbances that could be expected from a full scale mining operation. The proposed plans, released by the Johns-Manville Corp., described a mine near the present adit site, a haul road connecting the mine to the company owned Picket Pin ranch, and a concentrator and settling ponds on the ranch property. This development would probably remove the Picket Pin unit from elk winter range. Observations in 1975-76 indicated the elk may shift their activity center west of Castle Creek to the Pass Creek area. However, elimination of a major component of the winter range coupled with pressures on other areas would probably reduce the carrying capacity of this range.

Summary

Historically the Horseman Flats and Picket Pin Creek areas were probably important elk winter ranges. From 1900 to the late 1960's a few elk sporadically used this area. The herd increased in the early 1970's and by 1976 approximately 75 head were coming to this range each fall.

The elk winter range overlapped the boundary between private land and the Custer National Forest. The public land was used mainly for cover and bed grounds. Considerable feeding also occured on the grassy slopes. The private lands were almost exclusively used for feeding, particularly during periods of deep snow. To maintain a healthy, productive elk herd both the public and private sectors should be managed to minimize disturbance and to provide the basic needs of the herd.

Exploratory mining activity along the West Fork of the Stillwater River provided an insight into the effects of disturbances on the winter range. The elk avoided that section of the winter range traversed by the mine access road. The areas to which they moved, however, were either experiencing dramatic land use changes or they were in the planning stages.

The eastern slopes of Horseman Flats received heavy elk use during the period of mineral exploration. However, half of this 2 square mile area was subdivided for 210 summer cabins. Although cabin construction had been slow through 1976, the attrition of elk winter range was

continuing and eventually the carrying capacity of the range will be reduced.

The other major component of the elk winter range, Picket Pin, faced possible destruction from mine development. The Johns-Manville Corp. purchased the Picket Pin ranch, a major segment of the elk winter range. Company proposals listed the ranch as the site of a concentrator, settling ponds and possibly a smelter. A haul road connecting the mine and ranch would inhibit elk travel between Picket Pin and Horseman Flats. The proposed developments would probably remove the Picket Pin area from elk winter range.

Observations in 1975-76 suggested the elk moved northwest of Picket Pin to the Pass Creek area when disturbed. This movement may be an indication of shifts in range use to be expected from increased mineral development.

As summer homes construction continues and mineral development accelerates, the Horseman Flats-Picket Pin elk winter range will diminish in size and the carrying capacity will be severely reduced. Although the elk may compensate for the loss by using fringe areas, these are unknown quantities at present. The areas that may be lost are prime elk winter range capable of sustaining a healthy, productive elk herd. The loss cannot be mitigated.

Calving Areas

The wintering elk herd broke up into small groups and dispersed to their calving ranges in late May. New calves were first observed or reported during the first week of June. Calving areas were determined by plotting the locations of adult sightings during late May and early June. Movements of neckbanded animals also aided in delineating these areas. Two areas, Horseman Flats and Picket Pin, emerged as major calving grounds (Figure 5).

Calves were observed on Horseman Flats in early June of 1974 and 1975. The southwest timber edge, open timber and dense timber portions of the flats were used. In particular, the area between Rabbit Gulch and Horsehead draw above the road was preferred. Elk were observed feeding on open bunchgrass slopes, in aspen patches and in small openings within the dense timber. They used the dense lodgepole pine for bedding and were never observed more than 100 yards from cover.

The main calving grounds on the Picket Pin unit appeared to center around Bear Pen Creek and Swamp Creek. The area was bounded by Picket Pin Creek to the south and east and by Castle Creek on the north. Elk may also have calved further up Picket Pin and Castle Creeks. In 1974, they were observed along these creeks in mid-June. However, the data from 1975 suggested most of the calves were produced on the lower ranges. They then migrated with the adults up the drainages. Neckbanded animals were observed with calves along Bear Pen and Swamp Creeks and were later seen on Castle and Picket Pin Creeks.

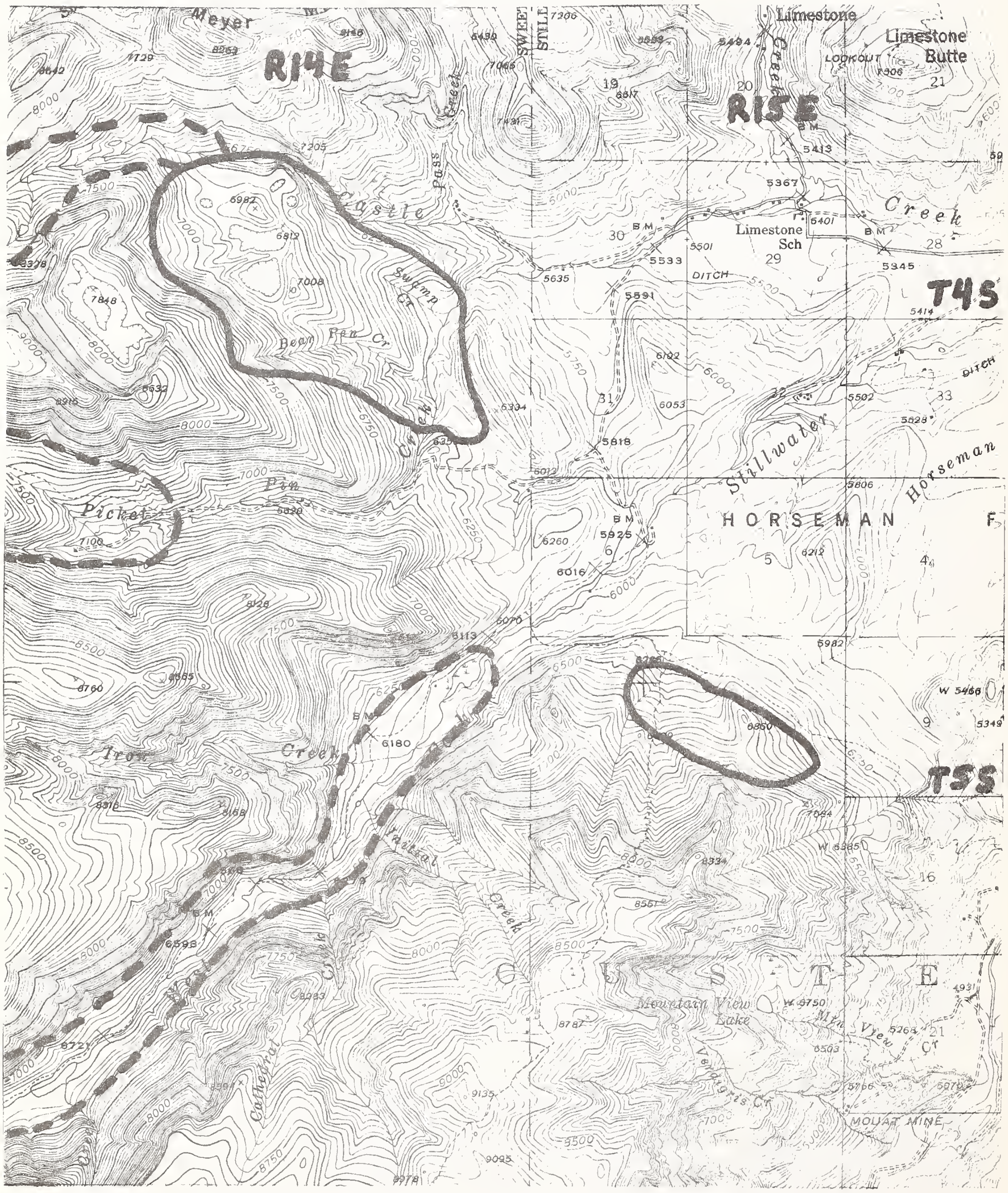


Figure 5. Known (_______) and suspected (--------) calving grounds of elk from the Horseman Flats-Picket Pin Creek winter range.

A third possible calving area was along the West Fork of the Stillwater River. On June 13, 1974 elk were observed scattered along the West Fork from Cresent Creek to Breakneck Park. On June 15 calves were sighted at Breakneck Park. It was possible these calves were produced on Horseman Flats or Picket Pin and migrated up the West Fork. However, the movements of marked animals from those areas did not support this theory.

Two factors influenced the elk movement along the West Fork in 1975. One was the Johns-Manville adit near the mouth of Cathedral Creek and the other was the late snow melt. On June 5, 1975, elk tracks were observed in a meadow approximately one-half mile above the adit. A cow elk was sighted in this meadow on June 7. On June 17 a cow was observed in a meadow between Cresent and Divide Creeks. On July 24, fresh calf tracks were observed in meadow just above the adit (tracks through a slide indicated they were made after July 18). These data suggested very few elk used the West Fork of the Stillwater River for a calving ground in 1975.

The elk migration, from winter to summer ranges, generally followed the receding snow line. In the low spring snow years of 1974 and 1976 this movement coincided with the calving season. In 1975 heavy spring snows retarded the migration for about two weeks. In 1975, the majority of calves were produced on the winter range. In the other two years the data were inconclusive in delineating specific calving areas. Although some calves were definitely produced on the winter range, the data suggested others were dropped along the migration routes. Suspected calving areas along the migration routes included the Sawmill meadows along Picket Pin Creek (at the junction of the two forks of Picket Pin Creek), the Iron Creek meadow, and the small openings along Castle Creek. It was also possible some calves were born on the lower reaches of the summer range.

Migration

Summer Range to Winter Range

The elk migration from the summer range to the winter range was partially distorted by the hunting season. However, two general routes were determined--Castle-Picket Pin and the West Fork of the Stillwater River (Figure 6).

In early September small groups of elk drifted north to the Iron Mountain and Picket Pin Mountain area. Tracks and sightings indicated they either wandered along the East Boulder River to Picket Pin Mountain or followed around the eastern side of Iron Mountain to Iron Creek. From Picket Pin Mountain they either dropped down into Castle or Picket Pin Creeks, or followed the ridge between Picket Pin Creek and the West Fork, or traveled southeast to Iron Creek. From Iron Creek they moved to Service Basin (a bowl above the mouth of Iron Creek) and then to the winter range. By mid-October a few elk were observed on the winter range. The majority, however, did not migrate until late October or early November.

The second major travel route appeared to be used later than the previously mentioned one. As snow and/or hunting pressure moved the elk off the higher portions of the summer range, they used the timbered

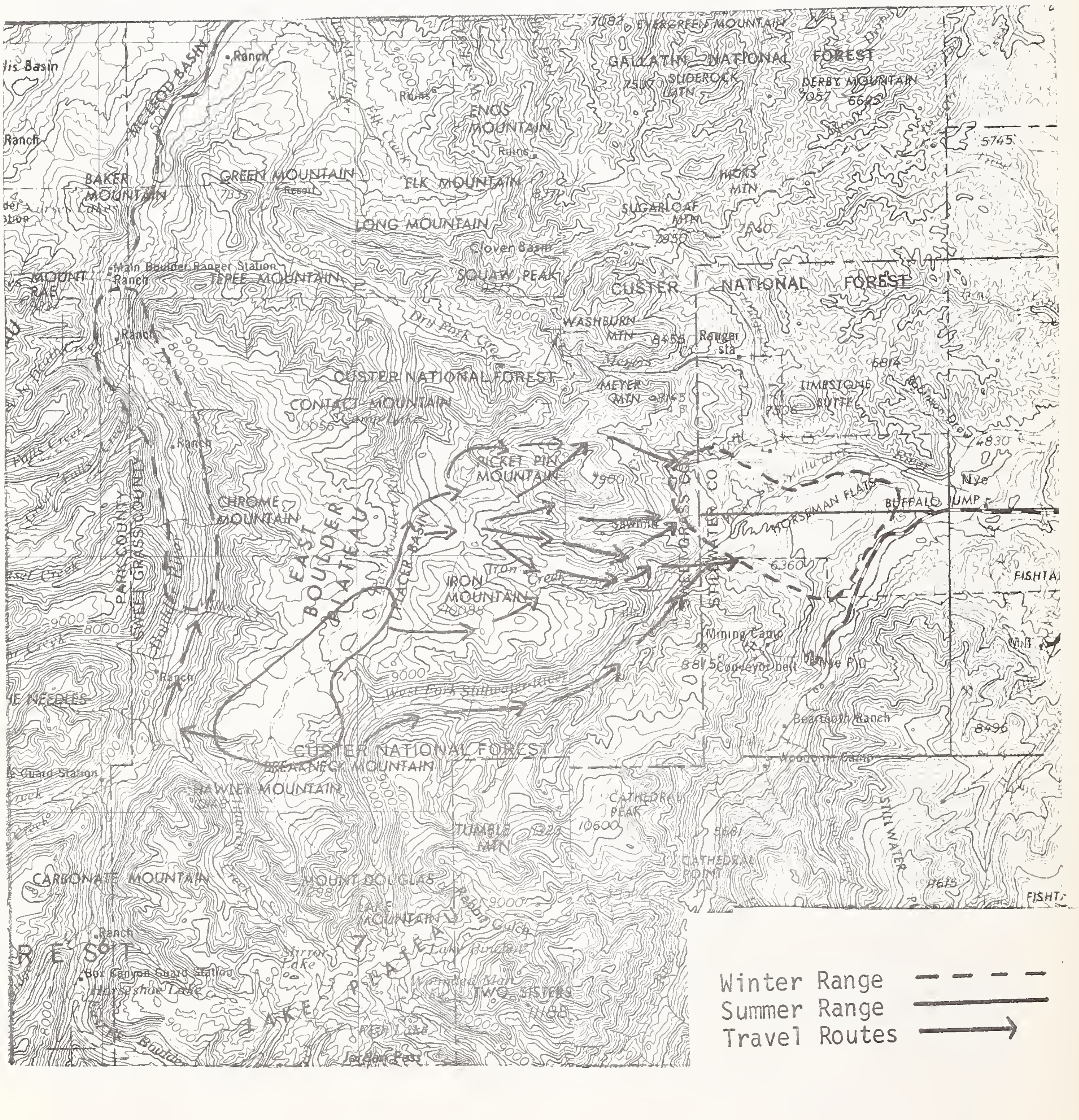


Figure 6. Migration routes of elk from the East Boulder plateau summer range to the winter range.

slopes between Trail and Divide Creeks. They then moved down the West Fork of the Stillwater River to the winter range. All elk were on the winter range by late November. An exception was a small antlered (3 or 4 points) bull who attempted to stay on the Trail Creek portion of the summer range in 1974-75. He survived most of the winter and was last seen on April 22, 1975. At that time he was contending with at least 3 or 4 feet of snow and had not traveled at all.

A significant portion of this elk herd migrated down the North Fork of Hawley Creek to the main Boulder River. No elk marked on Horseman Flats were observed wintering along the Boulder River. This suggested individuals followed the same general migration route each year.

Winter Range to Summer Range

The migration from the winter range to the summer range occurred during and immediately following calving. Two general routes were observed, and they appear to be associated with the calving areas (Figure 7).

Elk that calved in the Picket Pin area moved up either Castle or Picket Pin Creeks. The movements out of these drainages were probably controlled by snow depth. One neckbanded cow was observed along Picket Pin Creek on June 19, 1974. On June 24, she was in a small meadow on Iron Creek. By July 1, all neckbanded animals from Castle and Picket Pin Creeks were on the Trail Creek summer range.

The 1975 migration was set back about two weeks due to deep snow and a late runoff. A major portion of the herd used the Picket Pin route in 1975. One neckbanded cow was observed along Picket Pin Creek on June 25. She was next observed on the Iron Creek meadow on July 7 and had moved to Trail Creek by July 10. Three other neckbanded elk were along Picket Pin Creek on July 10. Two were observed on the Trail Creek slopes on July 18 and the third was seen there on July 23.

In 1976 elk were observed on a ridge separating the heads of the two forks of Picket Pin Creek. From this point they could move southeast into the Iron Creek drainage or west to the East Boulder drainage.

These data indicated the elk moved up Picket Pin Creek, crossed the divide and dropped into the Iron Creek drainage. They then either dropped down to the West Fork at Cresent Creek, or followed the southeastern edge of the plateau past Divide Creek to Trail Creek.

Elk migrating up Castle Creek may have crossed into the Picket Pin drainage and followed a similar route through Iron Creek to the summer range. Observations of a neckbanded cow in 1974 supported this route. She was sighted along Castle Creek on June 19 and by July 1 was on the Trail Creek slopes. Deep snow blocked most other travel routes.

Another possible route was to leave Castle and Picket Pin Creeks, pass over Picket Pin Mountain and travel up the East Boulder River to Placer Basin. In 1972 and 1973 elk were observed in Placer Basin in early July. However, one of the elk in 1973 was neckbanded and had previously been observed along Trail Creek. In 1974, elk were not observed in Placer Basin until late August.

Figure 7. Migration routes of elk from the winter ranges to the East Boulder plateau summer range.

The neckbanded cow observed in 1974 again migrated up Castle Creek in 1975. She was along Castle Creek on July 18 and was in Placer Basin on July 23. Tracks indicated she had crossed Picket Pin Mountain and followed the East Boulder River. No evidence was collected to support a similar movement out of the Picket Pin drainage.

The second major migration route was along the West Fork of the Stillwater River. This route appeared to be used by elk calving on Horseman Flats and along the West Fork. In general, the elk using this route preceded those from the Castle and Picket Pin route to the summer range. They mainly followed Forest Service trail number 90 along the West Fork to Trail Creek.

In 1974, neckbanded animals from Horseman Flats were observed in a meadow on Iron Creek. They were later seen at Trail Creek. These elk used the Iron Creek meadow before neckbands from Picket Pin were observed on it. In 1975, elk were observed using Service Basin (a bowl northwest of the mouth of Iron Creek). This suggested elk from Horseman Flats crossed the West Fork, traveled into Service Basin, and crossed over the ridge to Iron Creek. From Iron Creek they either dropped down to the West Fork or traveled through the open timber to the east and south of Iron Mountain and followed the plateau edge to Trail Creek.

In 1974, elk were backtracked along trail number 90 to the ford on the West Fork (just east of the mouth of Cathedral Creek). No tracks were noted on the southeast side of the river. In late 1974 the Johns-Manville company began work on an exploration adit (tunnel) just west of the ford on the West Fork. A portion of the Forest Service campground at Initial Creek was used for headquarters. The road, between the camp and the adit, was improved and a bridge was constructed across the West Fork near the ford. The road received considerable traffic through the spring of 1975 and diesel compressors were operating near the mouth of the adit. An attempt was made to determine what effect this activity had on the elk migration.

Elk tracks were first observed upstream from the adit along the West Fork trail on June 5, 1975. On June 7 one cow was observed in a meadow one-half mile above the adit. By backtracking it was determined that she had forded the West Fork 200 to 300 yards upstream from the bridge. She had bypassed the adit activity by staying in the timber on the southeast side of the river. Between the 18th and 24th of June another small group of elk moved through this area. From their tracks it was determined the road, between Cresent Creek and the bridge, was used to avoid a large rocky talus slope. Other elk probably crossed the West Fork downstream from the mouth of Initial Creek and went through Service Basin to Iron Creek. They then passed the adit at a higher elevation. Elk, therefore, were able to bypass the mining activity on the West Fork.

Fewer elk appeared to use the West Fork migration route in 1975 than in 1974. This was probably related to fewer elk calving on Horseman Flats in 1975. In late May 1974, 29 elk were observed on Horseman Flats. In 1975 the late spring high count was 8 head.

An attempt was made to quantify the use of each migration route (Table 19). In 1974 approximately 60 percent of the known winter elk herd used the West Fork migration route. In 1975, however, only 30 percent of the herd used this route. Use of Picket Pin Creek increased from 16 percent in 1974 to 48 percent in 1975. This indicated the mining activity may have affected the elk migration by shifting the bulk of the traffic to Picket Pin Creek.

Table 19. Percent of known wintering elk herd suspected of using each migration route between winter range and summer range in 1974, 1975 and 1976.

Year	Castle Creek	Picket Pin Creek	West Fork of Stillwater River	Unknown
1974	19	16	57	8
1975	9	49	27	15
1976 1/	11	29	27	33

1/ From Picton (pers. comm.).

Few counts were made in the spring of 1976. Picton's (pers. comm.) data indicated use of Castle Creek and the West Fork of the Stillwater River was the same as 1975. Use of the Picket Pin Creek route declined from the previous year. However, the route used by over 30 percent of the wintering herd was unknown. Observations in late May indicated few elk traveled up the river botton past the adit.

The movements of marked elk that survived for two migrations suggested some individuals used the same route each year. In 1974 a cow (no. 174) was observed along Castle Creek. In 1975 she was observed using the same route. Two banded elk (Nos. S-2295 and 164) traveled up Picket Pin Creek in both 1974 and 1975.

Two yearling cows (S-3545 and S-3546) were on Horseman Flats in early June 1974 and were among the early arrivals at Trail Creek. This suggested they used the West Fork migration route. However, in 1975 both cows were observed using the Picket Pin route. A yearling bull moved from the main Stillwater in late May 1974 to the Iron Creek meadow in mid-June. A week later he was at Trail Creek. In 1975, this bull used the Picket Pin migration route.

Too few relocations were obtained in 1976 to determine the routes used by individually marked animals.

The movements of these marked animals further suggested the mining activity along the West Fork of the Stillwater River shifted the normal migration route of many elk from the West Fork to Picket Pin Creek.

The elk wintering along the Boulder River migrated to the summer range via the North Fork of Hawley Creek. They traveled up this drainage in late June, crossed Breakneck plateau, and merged with the Horseman Flats elk along Trail Creek.

Aerial fiew of Horseman Flats elk winter range. The main Stillwater unit was on the left side of the flats.

BIGHORN SHEEP

Winter Range

Location

The bighorn sheep winter range was located in the Stillwater valley along highway 419 (Figure 8). It extended north of the old Mouat Mill and south to Woodbine Trailhead. The Stillwater River formed the eastern boundary and snow depth limited the westward movements. The total area of the winter range was approximately three square miles.

Topography

In general, the winter range lay in an east facing bowl. The north and south boundaries were formed by two prominent, rocky reefs running in an east-west direction. Steep rock outcrops and slopes characterized the north and south portions of the range. In the center, the slope dipped sharply from 8000 feet to about 5500 feet and then gradually decended to the Stillwater River at 5000 feet elevation. Numerous traversing mine roads were located in the northwest section of the range.

All creeks flowed in an east-west direction. Mountain View Creek flowed along the northern boundary. Verdigris Creek cut a steep walled canyon through the rock outcrop area in the northern portion of the range. Two unnamed intermittent streams flowed through the center of the range.

Vegetation

The vegetative components of the Stillwater bighorn sheep winter range have been described, with varying degrees of intensity, by South (1971), Pallister (1974) and Stewart (1975). South (1971) identified 17 general ecosystems in the Beartooth Mountains. Pallister (1974) quantitatively refined the ecosystems important to bighorn sheep. Stewart (1975), using the classification system of Pfister et al. (1974), intensified the quantitative descriptions of plant communities on the sheep ranges.

The Stillwater winter range can generally be classified as a Douglas-fir climax type. However, distinctive vegetative areas occurred within this general type. These were grouped as follows: Douglas-fir, bunchgrass, and deciduous types.

Douglas-fir

The Douglas-fir stands varied in density from scattered trees to closed canopy. In general, this type occurred above 6,000 feet elevation; however, in places it extended down to the Stillwater River.

The overstory was composed of Douglas-fir, lodgepole pine and limber pine. The relative abundance of these species varied from stand to stand. A few ponderosa pine trees were present in this type.

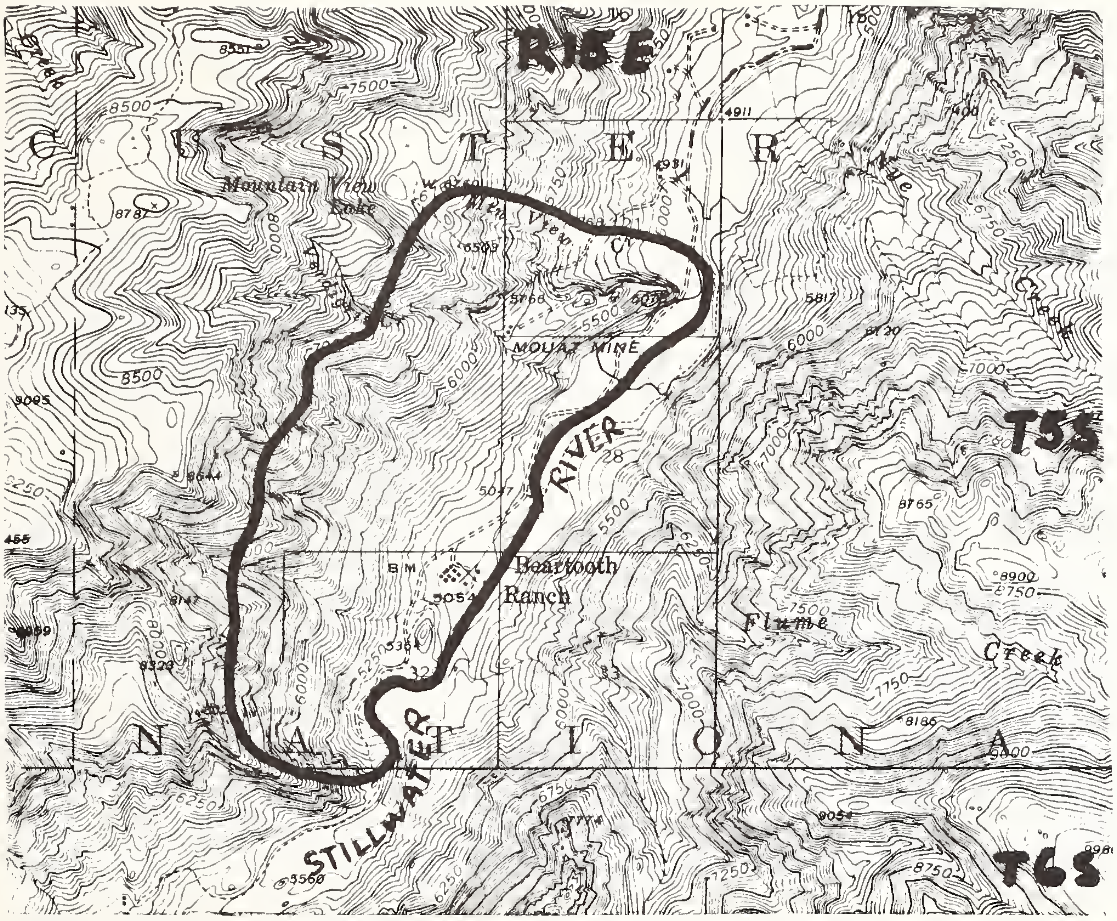


Figure 8. Location of Stillwater canyon bighorn sheep winter range.

Scars from past mineral development of Mouat property. Bighorn sheep winter range is on the left side and stockpiled chrome ore is in the lower center.

The understory varied according to tree density. Dominant shrubs were currant and horizontal juniper. Other shrubs included common juniper, chokecherry and skunkbush sumac. Bluebunch wheatgrass, Idaho fescue and sedges were the dominant grasses.

A unique situation of importance to the bighorn sheep occurred within this vegetative type. The northwest corner of the sheep range was traversed by numerous exploration roads associated with the Mouat Mine. Beginning in 1971, these roads were reclaimed by preparing the seed bed, planting a mixture of grass seed and fertilizing (Richmond and Adler 1974). The resulting dominant grasses were intermediate wheatgrass and slender wheatgrass. Yellow sweetclover was also present.

Bunchgrass

The dominant feature of the Stillwater winter range was the large, open, southeast facing bunchgrass slope. The open bunchgrass generally did not exceed 6000 feet elevation.

Scattered Douglas-fir and limber pine trees and seedlings occurred throughout this type. Skunkbush sumac was the dominant shrub. Big sagebrush was a major species at higher elevations. Additional shrubs included chokecherry, prickly rose, Oregon grape and currant.

The majority of the forbs were dried or decayed during the winter months. Those contributing to the winter flora were fringed sage, phlox, chickweed, pussytoes, golden aster, arrowleaf balsamroot and cudweed sagewort.

The dominant grasses were bluebunch wheatgrass and Idaho fescue. Bluegrasses occurred over most of the area and were abundant in the damp swales. Other grasses included Junegrass, downy chess brome and sedges.

A major feature of this vegetative type was the Beartooth Ranch property which was located between the Stillwater River and Highway 419. The ranch was heavily grazed by horses during the summer months and lightly grazed in the winter. The resulting vegetation included bluegrasses, downy chess brome and Idaho fescue as the dominant grasses. Fringed sage, phlox, pussytoes and chickweed were the main forbs and skunkbush sumac and rose the dominant shrubs.

Deciduous

Numerous small stands of quaking aspen occurred on the moist sites of the Stillwater winter range. Characteristic shrubs included chokecherry, prickly rose and snowberry. Bluegrasses were the dominant grasses.

Streamside Hardwood

This vegetative type occurred adjacent to the Stillwater River. As pointed out by Stewart (1975) this area had been subjected to heavy grazing in the past. He listed black cottonwood as the dominant overstory species and willow as the dominant shrub. Ticklegrass and sedges were the main grass and grass-like plants. Others included horsetail, wire rush, timothy and bluegrasses. Clover was the major forb.

An area with no recent grazing history north of the sheep range was examined. This area, however, was somewhat drier than the hardwood region of the winter range. Black cottonwood was the dominant overstory. Shrubs included chokecherry, snowberry, horizontal juniper and prickly rose. Of minor importance were water birch, buffalo-berry and common juniper. Bluegrasses were the common grasses. Western wheatgrass, timothy, Idaho fescue and sedges occurred rarely. Fringed sage was the only forb encountered.

Weather

The bighorn sheep winter range was located within the Stillwater chinook zone. This zone was characterised by very strong southwest winds. The Anaconda Company continuously measured average wind velocities adjacent to the winter range from June 5, 1972 to November 15, 1973 (Richmond 1974). A new machine, capable of measuring peak gusts, operated from February 3, 1974 through April 28, 1974. In addition Stewart (1975) measured the average monthly wind speeds on the sheep winter range for January through May 1975.

Richmond (1974) recorded a maximum wind velocity of 101 MPH on March 5, 1974. His highest hourly average speed was 46 in 1972, 42 in 1973, and 44 in 1974. The highest two week averages were 19.5 MPH in December 1972, 18.0 MPH in January 1973, and 18.2 MPH in February 1974. The monthly averages recorded by Stewart (1975) varied from 5.60 MPH in May to 19.88 MPH in April.

The only temperature data for the winter range were recorded by Stewart (1975) from January through May 1975. The average January 1975 temperature was 26.4 F. This compared with the 30 year average of 24.0 F recorded at the Mystic Lake (elevation 6,600 ft.) weather station. The 1975 January average at Mystic Lake was 22.3 F which suggested 1975 was colder than normal and the average January temperature may be as high as 30 F on the Stillwater winter range.

Precipitation data were collected from 1972 to 1976 along the Picket Pin drainage approximately 5 miles northwest of the winter range (Table 11). In addition, winter snow depths were recorded from 1971 to 1976. The Lower Picket Pin snow course (6200 ft. elevation) was representative of the sheep winter range (Table 9). The course, however, was protected from wind by timber and had a slight northeast exposure. Therefore, it retained snowfall for longer periods than the exposed winter range. The Middle Picket Pin snow course (Table 16) at 7250 feet elevation was representative of the upper limits of the winter range.

The majority of the precipitation during the winter months fall as snow. Due to the warm temperatures, the east and southeast exposures, and the chinook winds, accumulation was rare. Even on the protected snow course, depths of two feet were uncommon. Data from the middle snow course suggest the sheep were generally limited to below 7000 feet elevation from January through April.

Bighorn Sheep

Records of bighorn sheep in the Stillwater Valley prior to 1900 were lacking. One early resident reported seeing sheep on the present winter range in 1908 (D. Whited pers. comm.).

The U.S. Forest Service estimates the number of sheep in the Beartooth Mountains varied between 57 and 85 from 1925 to 1930 (McLean 1930). In 1935-36 and 1936-37 extensive winter game counts were conducted by the Forest Service (Cooney 1936 and 1937). They counted 46 and 45 sheep on the Stillwater winter range during these two winters. In referring to the sheep population of the entire Beartooth mountains, Cooney (1936) states, "The total number (102) is far below that of a number of years ago. They used to be very abundant but suffered a period of great losses due to disease (both verminous and baterial pneumonia) and are not much more than holding their own at present..." The 1937 report (Cooney 1937) listed sheep as "fairly scarce" in the 1890's, declining to "scarce" by 1910 and "very scarce" in 1937. He concluded sheep showed a continuous decline. However, the total counts in 1935-36 and 1936-37 were higher than the 1925 to 1930 estimates.

Data on the Stillwater herd were lacking for the period from 1937 to 1952. Estimates as high as 90 to 150 were recorded (Couey 1950; U.S. Forest Service 1954; Pallister 1974). However, D. Whited (pers. comm.) maintained sheep numbers on the Stillwater winter range showed no significant change during his period of residence(1908 to present). Stewart (1975) examined all available data and concluded, "it seems apparent a drastic decline of bighorns in the Stillwater probably did not occur but was hypothesized to reconcile the differences between the population estimates prior to 1954 and the actual counts of 1956."

Beginning in 1952, the Montana Department of Fish and Game periodically counted the sheep on the Stillwater winter range (Table 23). These data indicated the population probably numbered between 30 and 50 animals for the past 20 years. This population was closely monitored during the course of this study. The maximum number counted ranged from 33 in 1971-72 to 47 in 1973-74.

It appeared the number of bighorn sheep wintering in the Stillwater valley remained fairly constant from the early 1900's to the present. If a major die-off occurred it was probably in the mid to late 1800's.

Mining

The northern boundary of the bighorn sheep winter range overlapped a highly mineralized zone known as the Stillwater Complex. The Mouat properties, adjacent to the sheep range, have had a long history of mineral development.

Prospecting in the Stillwater area began in the 1860's. In 1866, Captain Jeff Standifer lead a prospecting party along the northern face of the Beartooth mountains (Henderson 1866). Individuals and parties continued to explore the area through the 1870's in spite of the fact they were on the Crow Indian Reservation (Annin 1964).

In 1883, a party of prospectors discovered a copper lead on the main Stillwater River. This precipitated a run of claim staking. The Stillwater Mining Company was formed in 1884 and was sold to the Minneapolis Mining and Smelter Company in 1885. By 1887 a small city (Nye City) of between 300 and 400 men had sprung up at the mining site and by the end of that year a small smelter was moved in and assembled. In addition, a lumber mill was constructed on the West Fork of the Stillwater River. However, in 1888 government surveyers declared the town was on the Crow Indian Reservation. The smelter was dismantled and the town was abandoned shortly thereafter (Annin 1964). In 1890, the mineralized area was removed from the Crow Indian Reservation which resulted in a new wave of exploration. In 1904, the prospectors banded together and sent a large shipment of ore to Omaha for smelting tests. Poor results from these tests ended this "boom" (Annin 1964).

In 1905, T.C. Benbow found chrome deposits on Little Rocky Creek and William M. Mouat, reworking the old Minneapolis Mining Co. claims, also found chrome deposits at Nye. Some ore was removed but neither was able to mine extensively due to high production costs.

During World War I, the Gish mine on the Boulder River and the Benbow mine were opened for chromite production.

Interest in this area subsided until World War II when overseas shipments of chromite ore were halted. At this time the U.S. Government contracted the Anaconda Company to open the Benbow and Mouat mines for chrome production. Millions of dollars were expended on the facilities to handle the chrome ore and on living quarters for approximately 2000 workers and their dependents.

Dayton (1971), claimed both mines produced a little over 100,000 tons of chrome concentrate. Richmond (1974) stated the Mouat mine produced 29,538 tons of chrome concentrate from April 1, 1943 to October 29, 1943 when the Government terminated all contracts and leases.

The mines remained inactive until the Korean conflict. In 1952, the U. S. Government again considered the Stillwater chrome ore to be vital to national security. A lease agreement was made with the American Chrome Co. (a subsidiary of Goldfield Consolidated Mines) to reopen the Mouat mine. Over an eight year period, 930,000 tons of chrome concentrate were produced. The contract was terminated in 1961 and the concentrated ore was stockpiled on the Mouat property.

In 1966, the Anaconda Company acquired the Stillwater holdings from the American Chrome Co. and a majority interest in the Mouat properties. Intensive exploration activity for copper-nickel mineralization commenced in 1967 and consisted of drilling, trenching, and surface and underground geologic mapping. In addition, small quantities of ore were obtained from two adits for metallurgical testing. Activities since 1971 have been on a reduced scale to meet the mandatory requirements to maintain valid claims (Richmond 1974).

Grazing

The Stillwater bighorn sheep winter range included pastures of the Beartooth Ranch. The ranch had a long history as a dude enterprise and carried a large number of horses during the summer. Prior to 1967 the horses grazed over most of the bighorn sheep winter range and apparently severely deteriorated the range (Foss 1967). In 1967 the U.S. Forest Service constructed a fence across the winter range along highway 419. The fence restricted the horses to the area below the road leaving that above the road for game use.

The ranch property continued to receive very heavy seasonal grazing. This resulted in major vegetative changes.

In 1972, point intercept and two-step, transects were read to quantify the major differences above and below the fence (Table 20 & 21). The results from both methods indicated forbs were more abundant on the ranch while grasses were dominant above the road.

Stewart (1975) found a similar difference using the Daubenmire sampling technique. He found bluebunch wheatgrass and Idaho fescue were reduced on the ranch while downy chess brome, bluegrasses, fringed sage, pussytoes and phlox all increased.

The sheep were frequently observed crossing the road and fence to feed on the ranch property. A definite preference for this area was exhibited since they traversed the ungrazed range to get there. Feeding site examinations indicated they were attracted by the exposed forbs, pussytoes, fringed sage and Hood's phlox (Stewart 1975). Forage production (pounds/acre) on the ranch, however, was less than half that above the road (Stewart 1975).

Although the sheep fed extensively on the ranch property, the area above the road probably supplied the bulk of the winter diet. This was particularly true during periods of snow, when depths of less than six inches would cover most of the vegetation on the ranch.

The fence definitely benefited the bighorn sheep winter range. It should be maintained and the policy of no livestock grazing above the road should be continued.

Hunting Season

In the late 1800's each hunter was allowed 8 bighorn sheep from September 1 to January 1 (Mussehl and Howell 1971). By 1902 the bag limit was reduced to 6 sheep (Annin 1964). In 1907 the season was shortened to October 1 to December 1 and only 1 sheep per hunter was allowed (Mussehl and Howell 1971). In 1915 the bighorn sheep hunting season in Montana was closed.

The closure remained in effect until 1953. The Stillwater - West Rosebud area was one of the first opened to hunting. In 1953, 5 permits were issued for the taking of 3/4 curl rams from October 15 to November 15.

Table 20. Point intercept transects comparing grass and forb abundance above and below the road on bighorn sheep Stillwater winter range.

	GRASS	FORB	BARE GROUND
Above Road	65%	24%	11%
Below Road 1	38%	55%	07%
Below Road 2	31%	53%	16%

Table 21. Two-step transects comparing grass and forb abundance above and below the road on the bighorn sheep Stillwater winter range.

	GRASS	FORB
Above Road 1	65	35
Above Road 2	59	41
Above Road 3	59	41
Average Above Road	61	39
Below Road 1	32	68
Below Road 2	28	72
Below Road 3	38	62
Average Below Road	33	67

In 1954 and 1955, 8 permits were issued. In 1956 the season was shortened to one week (October 1-7) with no restriction on the number of hunters. From 1956 to 1975 the season varied from one to three months in length, the bag limit remained one 3/4 curl ram per hunter and an unlimited number of permits were issued each year.

A restriction was introduced in 1972. A successful hunter (after January 1, 1971) must wait seven years before again applying for a sheep permit.

In 1975 the Beartooth Mountains were divided into three hunting districts (Figure 9). Area 500 extended from the Stillwater River to the Boulder River and encompassed the known range of the Stillwater sheep herd. In addition, a "harvest quota" of 4 rams was imposed. Although an unlimited number of permits were issued, the season was to be closed on a 48-hour notice once the quota was reached. A further restriction was introduced in 1975 when the sheep winter range, from Woodbine trailhead to the Mouat Mill, was closed to hunting.

Harvest data for specific sheep herds were unavailable prior to 1975. Beginning in 1965 harvest data for Hunting District 501 (Beartooth Mountains) were estimated from hunter questionaires. From 1965 through 1969 the number of hunters in the field varied from 22 to 73 and the kill from 2 to 11. No data were available for 1970. In 1971 the number of hunters increased to 144 and continued to climb to 338 by 1974. The number dropped to 268 in 1975. The estimated harvest rose to 22 in 1971 and peaked at 33 in 1974. In 1975 the harvest dropped to 7 rams.

The Stillwater area apparently contributed little to the harvest in recent years. Known kills included 1 in 1973, 3 in 1974 and 1 in 1975. However, hunter interest in this area was indicated by the 84 permits purchased in 1975.

Capture and Markings

Eighteen bighorn sheep were captured and marked on the Stillwater winter range during the course of this study. Only 9 of the marked sheep were observed on the winter range in 1975-76. Of the remainder, 4 were known to have died and the fates of the other 5 were unknown (Table 22).

Attempts to bait the sheep into a trap were unsuccessful, probably due to mild winter conditions and the abundance of available forage.

The sheep were immobilized by an intramuscular injection of the drug "Rompun" (Xylazine, Chemagro, Division of Baychem Corporation, Kansas City, Missouri) a description of the action and effects of this drug were given by Gordon and Coop (1973). Dosages generally varied from 1 to 2 cc (100 mg/ml) but the sheep showed a wide tolerance and often multiple injections were administered. The drug was delivered using a "cap-chur" gun and darts (Palmer Chemical and Equipment Company, Inc.) A medium to low charge was used to propel a 3 cc dart.

Table 22. Fates of bighorn sheep banded on the Stillwater winter range.

SHEEP NUMBER	DATE MARKED	SEX	AGE	LAST OBSERVED ALIVE	FATE
S4284	03-08-73	F	8½+	05-05-73	Unknown
S4285	03-12-73	M	1½	11-18-74	Shot
S4286	03-13-73	M	½	05-29-73	Unknown
S4287	03-13-73	F	2½	05-05-76	
S4288	03-19-73	F	6½	03-19-73	Unknown
S4289	04-17-73	F	3½	05-05-76	
S3538	04-18-73	F	3½	11-18-73	Shot
S3543	12-18-73	F	4½	05-30-75	Unknown
166	03-05-74	F	1½	06-10-75	Died
162	03-20-74	F	5½	05-05-76	
167	03-20-74	F	½	05-10-76	
168	03-21-74	F	1½	07-31-74	Died
169	03-22-74	F	½	05-20-76	
41	01-14-75	M	½	07-08-75	Unknown
92	02-27-75	F	4½	05-10-76	
94	03-19-75	F	2½	03-19-76	
95	04-03-75	F	½	05-10-76	
69	05-20-75	M	1½	04-28-76	

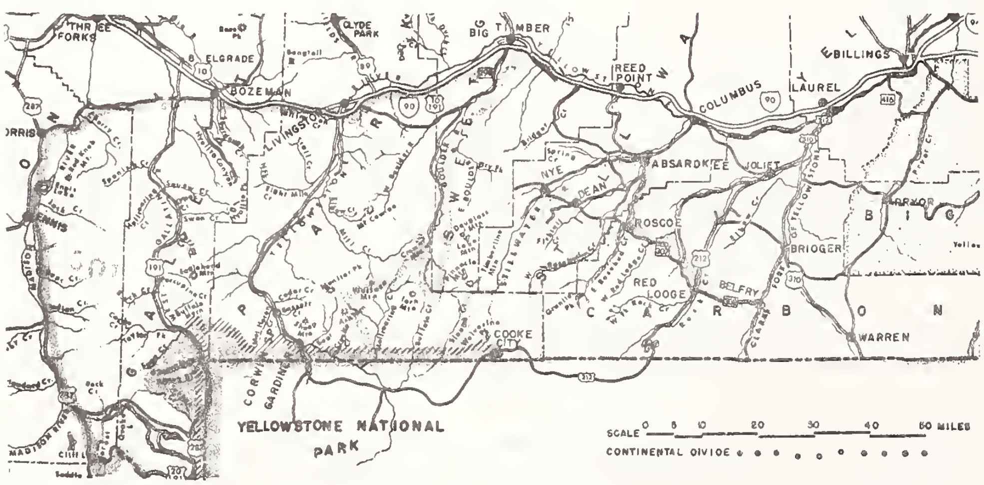


Figure 9. Location of bighorn sheep hunting district 500.

Two mortalities were directly attributable to the marking program. In one instance a ewe's femur was broken by the dart. She was shipped to Bozeman for use in the research laboratory but died within a few days. Another ewe was not located soon enough after she went down. She drowned in her own regurgitated fluids.

All immobilized sheep were ear tagged and neck banded. A numbered metal tag was attached to the right ear and a numbered, colored, plastic, pendant tag was inserted through the left ear. Two males, nos. S4285 and S4286 were not marked with plastic tags.

The adult ewes were neck banded with six inch wide bands. These consisted of strips of "Saflag" (red, white, blue and black) sewn onto a belt webbing backing. The bands were individually coded by color and pattern. Two males (nos. S4285 and S4286) were marked with similar bands three inches wide. Two lambs (nos. 167 and 169) received three inch wide, numbered, yellow, Herculite vinyl coated nylon bands with no backing and one lamb (no. 41) was fitted with a numbered, three inch wide, single strip of Saflag. A lamb (no. 95) and a yearling ram (no. 69) received six inch wide, numbered, Herculite bands.

The Herculite bands appeared to be superior to the webbing backed Saflag bands. After three years wear much of the Saflag had been torn off making identification difficult. In addition, the added weight of the backing material wore the hair off the neck region. The Herculite bands were easily identified after two years of wear. The six inch wide bands were the best. Saflag without backing was not recommended.

In 1972-73 two of the collars put on ewes (nos. S4289 and S3538) contained radio transmitters. The transmitters operated in the 151 MHz range. The last signal was received on June 18, 1973. One of the radios was retrieved in November 1973. It was badly corroded and one of the batteries had fallen out.

In 1973-74, four more ewes (nos. S3543, 166, 162 and 168) were fitted with radio transmitters operating in the 151 MHz range. The radios and batteries were encased in heater hose to prevent corrosion. These transmitters operated for about a month until a Billings answering service increased its output and completely overpowered them. Two of the radios have since been recovered and, although the batteries were weak or dead, they were still in operating condition.

In 1974-75 two radios transmitting in the 180 MHz range were put on ewes no. 92 and 94. The batteries and radios were encased in beeswax in a metal box which was bolted to the neck band. Both radios quit working shortly after they were put out. The cause of the failures was unknown. It was noted in 1975-76 that one ewe had lost the radio package.

Distribution and Movements on the Winter Range

D Whited (pers. comm.) claimed sheep were on the Stillwater winter range when he arrived in 1908 and have occupied it every year since. Over the years isolated observations of sheep some distance from the winter range have been reported. In most instances, however, these were rams.

Rams were seen north of the Mouat property on Silver Creek, on Horseman Flat, on Limestone Butte, along Castle Creek, Picket Pin Creek, and the West Fork of the Stillwater River. On April 24, 1976 a yearling bighorn ram was observed with McKinsey's domestic sheep along Lodgepole Creek. He appeared prior to a heavy spring storm and left four days later before the storm had abated. He was approximately 7 air miles north of the main winter range and was never observed on the winter range during 1975 - 1976.

D. Whited (pers. comm.) also maintained rams wintered along the upper Stillwater River in the 1920's and 30's from Tripod Hill (Flood Creek) to above Big Park (Wounded Main Creek). Apparently the Forest Service put out salt for these sheep in the Tripod Hill Area. In March, 1959, 13 legal rams were observed in this area (Ellig 1959). No sheep have been observed wintering along the upper Stillwater River in recent years.

Distinctive ram herds were not observed during the winters of 1971-72 through 1974-75. Neither Pallister (1974) nor Stewart (1975) reported separate ram herds on the Stillwater winter range. However, in 1975-76 three rams (one 2½ years old, two 3½ years old) appeared to segregate themselves from the ewe herd after the breeding season. They were generally observed, following heavy snow storms which forced them to lower elevations, in the vicinity of the old Mouat Mill. They apparently stayed at the extreme northern edge of the winter range.

The movements of ewes, lambs and young rams on the winter range were determined by following marked animals. These sheep generally moved to the winter range by mid October, were repeatedly observed through the winter, and left the area by mid June. Therefore, approximately 8 months each year were spent on this 2 - 3 square mile winter range.

As noted by Pallister (1974), the first sheep to arrive on the winter range in late September and early October generally restricted their movements to the higher rocky reaches of the range. In particular they used the seeded mine roads on the Mouat property. The disturbance from the hunting season, which was in progress at this time, may have contributed to restricting the sheep to this escape terrain. By late November they settled on to the main winter range.

Movements during the winter were generally associated with travel between bedding and feeding grounds. The sheep bedded on the valley slopes at higher elevations. In late morning they ventured down the slopes to the bunchgrass flats where they fed during the day. In early evening they drifted back to the higher bed grounds. During five winters of observation no definite affinity for a specific bedding area was observed.

Although the ewes, lambs and young rams formed loose knit groups and often separated into two or more bands, the movements of marked animals proved these were not separate entities. This would be expected on such a small winter range.

Pallister (1974) and Stewart (1975) determined the standard diameters (a circle which contains 68.26% of the relocations) for the marked animals. Pallister (1974) recorded an average standard diameter for three marked sheep of 0.94 miles in December 1973. Eleven marked sheep averaged 0.78 miles from January through April 1975 (Stewart 1975). Both authors attributed these relatively small standard diameters to the small size of the winter range.

Major shifts in the daily activity patterns appeared to be in response to adverse weather conditions. The sheep usually avoided the open bunchgrass flat during and immediately following heavy snowstorms. They generally fed on the open timbered and rock outcrop slopes on and adjacent to the bedding grounds. In particular, they would move to the steep, rock outcrop canyon area between Verdigris Creek and the Mouat Mill; Stewart (1975) noted a similar movement.

Stewart (1975) recorded wind velocities on the winter range but did not attempt to relate this to the activity patterns of the sheep. Although quantitative data were lacking, numerous observations indicated the sheep used timbered, timber edge and rock outcrop areas more during periods of severe wind. When they ventured onto the bunchgrass flats they were constantly moving and spent less time grazing.

Movements of marked animals indicated they readily moved from one portion of the winter range to another. For example, ewe no. S4287 was observed on the Mouat mine roads on November 12, 1974. The next day she was on the Beartooth Ranch near their driveway. On December 12, 1974, four marked ewes (nos. S4287, 166, 167, 169) were seen on the Mouat Mine Roads. The following day three of the ewes (nos. 166,167,169) were at the southern edge of the range in the rocks above Woodbine trailhead and the fourth (S4287) was on the slope in the center of the range.

Most of the marked sheep were regularly observed throughout each winter. With one exception, the longest period between resightings was one month (ram S4285 and ewe 166 were not seen during April 1974). The one exception, ewe no. 169, was banded as a lamb on March 3, 1974. She was first relocated on May 3, 1974 on the Mouat mine roads. She returned to the winter range in the fall of 1974 and was regularly observed until February 28, 1975. Stewart (1975) assumed she had died. However, she reappeared in the fall of 1975 and remained throughout the winter.

Two marked ewes restricted their movements on the winter range. Ewe no. S4284 was banded in the canyon near Verdigris Creek on March 8, 1973. She moved south to the bunchgrass flats and remained there for two weeks. On March 26, 1973 she was observed on an open bunchgrass knob at the south end of the range between the Stillwater River and the Woodbine campground road. She remained on this knob throughout the winter and spring and was last seen on May 5, 1973.

Ewe no. 162 appeared to restrict her movements to the north end of the range. Of 23 observations in 1974-75 and 1975-76, 20 were on or north of the rock outcrop area just south of Verdigris Creek. She was seen twice on the north end of the bunchgrass flat and only once in the middle of the flat. For comparison, ewe no. S4287 was observed 46 times in the same two years. Seventeen of these sightings were from the north end of the range, 25 from the flat or slopes in the middle of the range, and 4 were from the extreme southern boundary. Stewart (1975) determined the center of activity for all marked sheep from January through April 1975. Ewe no. 162's activity center was further north than any of the others.

Data from the marked animals indicated there was considerable individual variation in range use and movement patterns. They also indicated the majority of the sheep using the winter range were accounted for in the maximum counts of each winter.

As spring approached and the snow line receded, the sheep began drifting to the higher reaches of the winter range. The daily total of sheep observed on the winter range started declining by mid May. By early June most sightings were from the Mouat mine roads or the rocky reef above Woodbine Trailhead.

Population Dynamics

Numbers

Actual counts of bighorn sheep wintering in the Stillwater valley have varied from 21 to 55 over the past 40 years (Table 23). Since different observers recorded these observations, there was no control over the accuracy of the classifications nor was it known what percent of the total herd was counted. These problems were partially overcome by averaging segments of the data.

The 1936-37 count was obtained from multiple observations and represented the pre-hunting season population. Counts during the 1950's and 1960's were averaged to reduce sampling errors. Population figures from 1971-72 through 1975-76 were the maximum unduplicated counts for each year.

The average herd size observed in the 1950's was 40 sheep. By the late 1960's (no counts were made from 1959-60 through 1964-65) the average herd size had dropped to 25. It increased back to 40 sheep in the 1970's.

Since 1972-73 the total sheep population stabilized at between 40 and 50 animals. When compared to previous counts, the population was apparently at or near the carrying capacity of this range.

Breeding Season

Observations on breeding activities were recorded in 1974-75 and 1975-76. The earliest breeding behavior was observed on November 27, 1974 and the latest was on January 6, 1975 and January 8, 1976. Smith (1954), studying Idaho sheep, found "the earliest actual breeding which was observed during this study was on November 17. The intensity and frequency of rutting activities reached the most fevered pitch around the first of

Table 23. Actual counts of bighorn sheep on the Stillwater Winter range.

Date	Rams	Ewes	Adults	Lambs	Uncl.	Lambs/100 ewes	Total	Source
1935-36					46		46	Cooney(1936)
1936-37	14	18	32	13	-	72	45	Cooney(1937)
1/1/42					27		27	Ekwortzl (pers. comm)
1951-52			34	5	-		39	MT F&G files
1953-54					32		32	"
1/11/54	9	17	26	10	-		36	Ikerman (In Buechner 1960)
April 1954			49	6	-		55	MT F&G files
2/6/56	5	37	42	10	3		55	"
3/20/56	10	27	37	7	-		44	"
11/24/56	7	16	23	8	-		31	"
4/19/57	5	21	26	2	8		36	"
5/23/57			23	4	-		27	"
12/17/58	13	24	37	8	-		45	"
Av. 1950's	8	24	33	7	-	29	40	
1965-66	1	17	18	3	-		21	MT F&G files
12/9/66	1	15	16	5	-		21	"
2/10/67	2	15	17	10	-		27	"
2/19/68	6	19	25	2	-		27	F. S. files
2/28/68	7	20	27	6	-		33	MT F&G files
4/17/69	5	14	19	2	-		21	"
Av. 1960's	4	17	20	5	-	29	25	
1/28/70	2	21	23	5	-	24	28	MT F&G files
1971-72	4	18	22	11	-	61	33	Stoneberg(1973)
1972-73	6	22	28	14	-	64	42	"
1973-74	7	25	32	15	-	60	47	Stoneberg(1974)
1974-75	8	27	35	11	-	41	46	Stewart(1975)
1975-76	7	28	35	9	-	32	44	
Av. 1970's	6	24	29	11	-	46	40	

December. Breeding activities tapered off during the latter part of December, and copulation was not observed in January."

In 1975-76, three of the larger rams separated from the other sheep. The last date these rams were seen with the ewe herd was January 21, 1976. This suggested the breeding season ran from mid November through mid January.

Although all age classes of rams were observed chasing and attempting to breed ewes, only 3½ year old rams were seen successfully copulating. Woodgerd (1964) determined yearling rams were capable of breeding. One yearling was observed attempting to mount a ewe during this study.

In the late 1960's public concern was voiced about the poor condition and poor lamb crops of the Stillwater herd. In reply, the Montana Department of Fish and Game transplanted four rams (all were 1½ to 3 year old) from the Sun River area to the Stillwater. All rams were ear tagged. Two were released in 1968 and two in 1970.

On February 19, 1968 two ear tagged rams (one yearling and one ½ curl) were observed on the Stillwater winter range (Forest Service files). No other observations have been recorded for these sheep.

The rationale for transplanting these rams was the Stillwater herd was isolated and suffering from inbreeding. This appeared unlikely due to the close proximity with other sheep herds, the mobility of rams during the rut, and to the fact rams from the Stillwater summered with other rams at the head of the Boulder River. However, counts and classifications during the breeding season did not indicate an ingress of rams from other areas (Table 26).

Demarchi (1972) countered a question on inbreeding by citing high reproductive rates. Following this line of thinking, production on the Stillwater was apparently low prior to the transplants, was high from 1971-72 through 1973-74, and dropped in 1974-75 and 1975-76. Although other factors (i.e., fence construction) were involved, the problem of inbreeding must be considered when dealing with the Stillwater herd.

Lamb Survival

Production and/or survival of lambs, as indicated by counts on the winter range, varied considerably over the years (Table 23). The highest lamb to ewe ratio (72 lambs/100 ewes) was recorded in 1936-37. The ratio averaged 29 lambs/100 ewes in both the 1950's and the 1960's and increased to 46 lambs/100 ewes in the 1970's. For comparison, winter lamb-ewe ratios in the Sun River, Montana area ranged between 34 and 59 from 1955-56 through 1972-73 (Schallenberger 1972; Frisina 1974). Comparable averages were 53 lambs/100 ewes in the1950's, 45 lambs/100 ewes in the 1960's and 49 lambs/100 ewes in the 1970's. Horejsi (1972) suggested low lamb survival was indicative of a decreasing herd and high survival of an increasing herd.

These data indicated the Stillwater herd was on a downward trend throughout the 1950's and 1960's. Stelfox (1974) suggested poor winter range conditions did not decrease lamb production but were manifest in poor yearling recruitment, indicating heavy winter lamb losses. The data in table 23 support this view. Early winter counts generally recorded more lambs than late winter and spring counts. This suggested the competition with domestic livestock and overabundant mule deer populations on the winter range may have contributed to the decline in sheep numbers.

In 1967 the Forest Service fenced the domestic livestock off a major portion of the sheep winter range. The mule deer populations apparently peaked in 1950's and have declined since. In 1971-72 an early winter ratio of 61 lambs/100 ewes was observed (Stoneberg 1973). No lamb mortality was noted through April 1972. High survival ratios continued for 1972-73 (64 lambs/100 ewes) and 1973-74 (60 lambs/100 ewes). As expected, the adult segment of the population increased. The largest number of lambs (15) ever recorded for this winter range was observed on February 8, 1974.

In 1974-75 Stewart (1975) observed 41 lambs/100 ewes. He noted high lamb survival throughout the winter. By 1975-76 the ratio had declined to 32 lambs/100 ewes. Assuming no major lamb loss occurred during summer and fall, then this herd may have been limiting production in response to crowded conditions on the winter range. Stelfox (1974) found no relationship between production and deteriorating range conditions. The Stillwater herd, however, was not faced with a lack of forage but with a very limited (2-3 square miles) winter range.

It was noted in 1974-75 and 1975-76 that marked yearling and two year old ewes were not accompanied by lambs on the winter range (Table 24). The youngest marked ewe with a lamb was 3½ years old. One ewe (no. S4287) had a lamb every other year while another ewe (no. 162) had a lamb for three consecutive years. The oldest known age ewe with a lamb was 7½. Autopsies on two marking mortalities revealed the 4½ year old ewe was pregnant with one fetus while the 2½ year old ewe was open (Stewart pers. comm.).

Table 24. Production history of marked ewes on the Stillwater winter range.

	YEAR							
	1972-73		1973-74		1974-75		1975-76	
EWE NO.	AGE	LAMB	AGE	LAMB	AGE	LAMB	AGE	LAMB
S4287	2½	No	3½	Yes	4½	No	5½	Yes
S4284	8½+	No						
S4289	3½	-	4½	Yes	5½	No	6½	No
S3543			4½	No	5½	NO		
166			1½	No	2½	No		
162			5½	Yes	6½	Yes	7½	Yes
167			½	No	1½	No	2½	No
169			½	No	1½	No	2½	No
92					4½	No	5½	No
94					2½	No	3½	Yes
95					½	No	1½	No

Recruitment

Since yearling rams were readily distinguishable on the winter range and a 50:50 sex ratio was assumed, then yearling recruitment was estimated at twice the number of yearling rams observed. Marked yearling ewes showed considerable variation in horn growth and body size. Therefore, no attempt was made to separate this age and sex class. Various authors (Pallister 1974; Frisina 1974; Stewart 1975) recorded this increment as a ratio - yearlings/100 ewes. However, they did not separate the yearling ewes from the adult ewes. As a result the yearling ewes were included on both sides of the ratio thereby reducing it. In this report the ratio will be yearlings/100 adult ewes.

Table 25 gives the age and sex breakdown for the bighorn sheep herd wintering in the Stillwater valley during the five years of this study. In 1971-72 the yearling increment was quite small but production was very high. These figures were verified by the counts of the following year. The number of adult ewes remained the same, indicating recruitment of two year olds just offset adult losses. The large number of yearlings observed in 1972-73 reflected the high production observed the previous year. In addition, these data suggested a very high yearling survival rate (91%) through their second summer and fall. Adult ewe production was also extremely high.

Table 25. Sex and age classifications of bighorn sheep observed on the Stillwater Winter range 1971-1976.

Year	Total Rams 1/	Yrlg Rams	Total Ewes	Ad. Ewes 2/	Total Yrlgs 3/	Lambs	Yrlg. Surv(%)	Yrlg/100 ad ewes	Lamb/100 ad ewes
1971-72	4	1	18	17	2	11	-	12	65
1972-73	8	5	22	17	10	14	91	59	82
1973-74	8	2	25	23	4	15	29	17	65
1974-75	11	4	27	23	8	11	53	35	48
1975-76	7	3	28	25	6	9	55	24	36

1/ Includes known mortalities

2/ Ewes 2½ years old and older

3/ Assuming a 50:50 ratio of Male to Female Yearlings

In 1973-74 more adult ewes were added to the population than were available as yearlings the year before. This discrepancy may have been due to more yearling ewes than yearling rams being present in the 1973-74 population. In any case, the data indicated high survival and recruitment of two year old ewes.

The 1973-74 classifications showed poor survival of yearlings through their second summer and fall. This remained true even if twice as many yearling ewes as yearling rams were assumed. Adult ewe production remained high although it declined somewhat from the previous year.

The number of adult ewes remained static between 1973-74 and 1974-75, supporting the observation of few yearlings in the 1973-74 population. Yearling survival through 1974 increased to 53%. Adult ewe production continued to decline in 1974-75.

The adult ewe segment of the population increased slightly in 1975-76. This suggested recruitment of two year old ewes just offset mortality for the past three years. Production and/or survival of lambs to their first winter continued to decline. The 36 lambs/100 adult ewes observed in 1975-76 was the lowest recorded during this study. Yearling survival over summer and fall 1974 remained at 55%.

Rams under 4½ years old could be aged quite reliably by counting the annual horn rings (Giest 1966). Table 26 shows the age stucture of the ram populations observed on the winter range during the course of this study.

These data indicated survival of rams during their second summer and fall was highly variable (from 29 percent to 100 percent). Stewart (1975) suggested the high yearling mortality may be offsetting the high survival of lambs. These data support his finding. Survival of lambs was highest in 1972 (Table 26). In 1973 yearling survival was the lowest. As lamb survival decreased the following two years, yearling survival increased.

Table 26 also indicated ram survival after the second winter was very high. In addition, there was no evidence of ram dispersal to different winter ranges.

Both Pallister (1974) and Stewart (1975) attributed the lack of older rams in this herd to hunting pressure. The findings of this study supported that assumption.

In summary, all available data indicated the bighorn sheep herd wintering in the Stillwater valley declined in numbers during the 1960's and increased in the 1970's. Apparently the decline was due to reduced production and/or survival of lambs throughout the 1950's and 1960's. This may have been a result of severe forage competition with domestic livestock and mule deer on the winter range.

The competition was greatly reduced in 1967 and the herd showed signs of improvement by 1971-72. Production was high in 1971 and

survival of the lambs through the winter and the following summer was also high. As a result the population increased to 42 sheep in 1972-73. Production peaked in 1972 and steadily declined since. Survival of yearlings through their second summer dropped drastically in 1973 and then improved over the next two years. The total number of ewes has gradually increased during the 1970's.

Due to the small size of the winter range, this herd may be responding to density dependent factors in population regulation. High production was offset by low yearling survival the following summer and vice-versa. This herd will probably maintain its numbers at the present population level of approximately 50 sheep.

Table 26. Age classes of all rams observed on the Stillwater winter range from 1971-1976.

	0.5 1/	1.5	2.5	3.5	4.5	5.5
1971-72	5	1	3	0	0	0
1972-73	7	5(4) 2/	2(1)	1	0	0
1973-74	7	2	3	2	1(0)	0
1974-75	5	4	2	3(1)	2(1)	0
1975-76	4	2(3) 3/	2	2	0	1(0) 4/

1/ Assuming a 50:50 ratio of male to female lambs.

2/ Total number of rams observed (number of rams left after subtracting known losses).

3/ () includes one ram observed 6-7 miles north of winter range.

4/ A 5½ year old ram harvested from Monument Mountain may have been from the Stillwater herd.

Food Habits

Food habits of bighorn sheep wintering in the Stillwater valley were determined from examinations of feeding sites. An estimated bite of vegetation was considered one instance of use. The results were presented as a percentage of the total use observed.

Pallister (1974) examined 9 feeding sites (2824 instances of use) in the fall and early winter of 1973. Stoneberg (1975) looked at 9 feeding sites (1787 instances of use) in early winter 1974. In 1974-75, Stewart (1975) conducted an indepth food habits study. He examined one feeding site (102 instances of use) in fall 1974, 3 sites (724 instances of use) in winter 1975, and 14 sites (9756 instances of use) in spring 1975. These data are summarized in table 27.

The sheep extensively used the reseeded Mouat mine roads in the fall. Both Pallister (1974) and Stewart (1975) recorded very heavy use on the introduced slender and intermediate wheatgrass. Pallister (1974) also noted some use on yellow sweetclover and raspberry.

Table 27. Summarized food habits of bighorn sheep wintering in the Stillwater Valley.

	Fall (Sept-Oct)		Early Winter (Nov-Dec)			Winter (Jan-Apr)	Spring (May)
	1[1/]	3	1	2	3	3	3
Grasses and Grass-like Plants:	85[2/]	100	35	38	40	50	83
Agropyron intermedium	36	37			13		
Agropyron spicatum			26	7	24	17	51
Agropyron trachycaulum	43	63					
Bromus tectorum			8	Tr[3/]	Tr	Tr	Tr
Carex spp.				Tr	Tr	5	Tr
Festuca idahoensis			Tr	11	Tr	7	Tr
Poa spp.				14		14	21
Forbs:	11	0	28	57	57	15	7
Antennaria spp.				8	22	Tr	Tr
Artemisia frigida			21	32	Tr	6	Tr
Artemisia ludoviciana	Tr		Tr	Tr	28	Tr	Tr
Chrysopsis villosa	Tr		6	8	Tr	Tr	Tr
Phlox hoodii			Tr	Tr	Tr	6	Tr
Shrubs:	3	0	38	6	2	34	11
Artemisia tridentata			33	Tr	Tr	10	Tr
Berberis repens				6		Tr	
Prunus virginiana						15	Tr
Rhus trilobata			5		Tr	7	
Ribes cereum							6

1/ Source: 1. Pallister (1974), 2. Stoneberg (1975), 3. Stewart (1975).

2/ Percentage of item in diet.

3/ Trace - less than 5% of total.

Note: Only plants with a significant amount of usage (over 5 percent) in at least one column were included.

As the winter progressed, the sheep moved down from the mine roads and fed on the bunchgrass flats and benches. Forbs and grass were of approximately equal importance in the early winter diets. The main grasses were bluebunch wheatgrass, Idaho fescue, downy chess brome, and bluegrasses. Forbs taken in major amounts included fringed sage, pussytoes, cudweed sagewort and golden aster. Pallister (1974) recorded heavy use on big sagebrush, however, this was obtained from one feeding site with snow depths in excess of 12 inches. If this one site were removed from the data his totals would be 36 percent grass, 57 percent forbs and 9 percent shrubs. Using these data and averaging the results of the three investigators, the following breakdown of the early winter diet was obtained: 38 percent grasses, 57 percent forbs and 6 percent shrubs.

The winter diet (January through April) recorded by Stewart (1975) indicated a shift from forbs to shrubs. The average composition was 50 percent grass, 15 percent forbs, and 34 percent shrubs. The main grasses and grass-like plants were bluebunch wheatgrass, bluegrasses, Idaho fescue and sedges. The only forbs taken in significant amounts were fringed sage and Hood's phlox. Chokecherry, big sagebrush and skunkbush sumac accounted for most of the increased shrub use.

The sheep generally browsed more during periods of deep snow. The winter of 1974-75 experienced deeper snowpacks and less wind than normal. Stewart's (1975) results, therefore, may have been biased towards shrubs. However, when he computed the percentage forage class utilization during periods of less than three inches of snow the results were 63 percent grass, 16 percent forbs and 21 percent shrubs. For comparison, the breakdown for greater than three inches of snow was 46 percent grass, 9 percent forbs, and 45 percent shrubs. The sheep apparently shifted from a grass-forb diet to a grass-shrub diet as the winter progressed.

As spring approached, the fresh green grass leaves were selected. Bluebunch wheatgrass and bluegrasses accounted for 72 percent of the May diet (Stewart 1975). Lesser amounts of Junegrass and Idaho fescue were also taken. Forbs comprised only 7 percent of the diet. The new green leaves of currant, snowberry, chokecherry and big sagebrush accounted for 11 percent of the recorded usage.

Pallister (1974) examined two rumen samples collected in Nov. 1973. The mean volume percentages for the major forage classes were 72.5 percent grasses, 7.5 percent forbs and 20 percent shrubs. Fringed sage was the main forb and Oregon grape the main shrub. Two winter (1972-73) rumen samples were examined by Stewart (1975). Grasses occupied 77 percent of the combined volumes, forbs 16 percent and shrubs 5 percent. Fringed sage was again the dominant forb with pussytoes and Hood's phlox occuring in lesser amounts. Big sagebrush, Oregon grape and lodge pole pine each accounted for one percent of the total volume.

Although the sheep occupied a variety of habitats and fed on a wide assortment of plants, the data suggested a few species made up the bulk of the winter diet. Grasses, mainly bluebunch wheatgrass, bluegrasses and Idaho fescue, were important throughout the winter.

The utilization of forbs varied considerably but appeared to be more important during early winter. Fringed sage was highly preferred followed by pussytoes and Hood's phlox. The use of shrubs was partially influenced by the snow depth. However, usage apparently increased during mid winter regardless of the snow. The major shrubs were big sagebrush, chokecherry, skunkbush sumac and Oregon grape.

Stewart (1975) sampled the canopy coverage and frequency of occurrence for grasses, forbs and low shrubs on the winter range. In general the main items in the diet were the most abundant species. Exceptions included sedges, chickweed and rose which were fairly abundant but received little or no use. Big sagebrush and chokecherry received heavier use than was indicated by their availability.

Stewart (1975) also measured the quantity and quality of forage on the Stillwater winter range. He estimated 646,340 lbs. of forage were available on 830 acres for an average standing crop of 779 lbs. per acre. This compared with 551, 422, and 200 lbs./acre forage production on Waterton, Banff and Jasper National Parks bighorn winter ranges respectively (Stelfox 1974). Stelfox (1974) considered the Waterton range to be in good condition and the Jasper range in poor condition.

The feed intake of pen raised bighorn sheep averaged about 1000 grams of natural vegetation per day (Hebert 1974). The intake rarely exceeded 1400 grams/day. Assuming 50 sheep used the Stillwater winter range for 240 days, then 24,516 grams of forage were available per sheep per day. These data suggested quantity of forage was not a limiting factor on this winter range.

Stewart (1975) expressed the quality of the forage as the percentage of protein in the main components of the sheep's diet. Measurements were made in mid-February and late April. In mid-winter bluebunch wheatgrass had the lowest protein level while bluegrasses, fringed sage and chokecherry were highest. Protein levels for all species increased during spring greenup. Bluebunch wheatgrass had the highest level by late April.

The protein intake of the sheep herd can be estimated by combining food habits and forage quality data (Table 28). It must be assumed that monthly percentage utilizations reflect actual proportions of plant use. The protein content of two items, Idaho fescue and sedges, which received considerable use in some months, were not measured. Values were extrapolated from late April measurements of these species from the West Rosebud area. It was also assumed protein values did not change significantly from January through March.

The results from table 28 indicated the protein intake varied according to the amount of bluebunch wheatgrass consumed. The February diet had the lowest protein level, 5.9 percent for all months calculated. Although comparisons were difficult, Herbert (1972) mentioned crude protein levels on a bighorn sheep winter range in British Columbia declined to two percent. In feeding trials he used diets ranging from

Table 28. Monthly protein intake determined from percentage of protein in forage species and percentage of forage species in diet. Data adapted from Stewart (1975).

	Mid-Feb[1]	Jan.		Feb.		March		Late-Apr.	May	
	%Protein	% Diet[2]	Gms Protein[3]	% Diet	Gms Protein	% Diet	Gms Protein	%Protein	% Diet	Gms Protein
Agropyron spicatum	2.2	16.9	3.7	34.3	7.5	1.9	0.4	18.9	51.0	96.4
Poa spp.	10.7	15.9	17.0	4.7	5.0	24.2	25.9	15.6	21.1	32.9
Artemisa frigida	10.0	6.9	6.9	3.0	3.0	8.7	8.7	14.7	0.8	1.2
Phlox hoodii	7.8	3.3	2.6	Tr	-	16.7	13.0	8.4	Tr	-
Artemisia tridentata	8.6	12.9	11.1	6.9	5.9	0.6	0.5	10.0	1.1	1.1
Prunus virginiana	9.8	16.8	16.5	14.1	13.8	10.6	10.3	12.0	1.3	1.6
Rhus trilobata	8.1	11.5	9.3	1.3	1.1	1.7	1.4	9.0	-	-
Carex spp.	7.1	2.4	1.7	15.4	10.9	3.2	2.3	7.1	3.6	2.6
Festuca idahoensis	6.8	1.4	1.0	Tr	-	18.5	12.6	13.4	2.4	3.2
Total:		88.0	69.8	79.7	47.2	86.1	75.1		81.3	139.0
Av. Percent Protein		7.9		5.9		8.7			17.1	

1/ Percentage of protein in forage species measured in Mid-Feb. and Late-April.

2/ Percentage of forage species in diet as determined from feeding site examinations.

3/ Calculations based on an intake of 1000 gms. of forage.

3.22 to 5.87 percent protein (Herbert 1974). These data indicated the Stillwater winter range supplied sufficient protein for the maintenance of this sheep herd.

The protein intake increased in March due to a shift from bluebunch wheatgrass to the more nutritious bluegrasses and Hood's phlox.

April was a transition month and was not included since protein levels were changing rapidly. A dietary protein level of 10.1 percent was obtained by averaging the levels determined by using the low winter values and the higher spring values.

In May the protein rich green leaves of bluebunch wheatgrass and bluegrasses accounted for almost three quarters of the food intake.

Although these data were incomplete, they indicated the quantity and quality of forage on the Stillwater winter range were sufficient to satisfy the dietary requirements of the sheep. This suggested sheep numbers were not being limited by the available food supply.

Parasites

Many Rocky Mountains bighorn sheep herds have suffered periodic, severe, population declines (Buechner 1960, Stelfox 1971). Forester and Senger (1964), Stelfox (1971), Demarchi (1972) and others indicated earlier workers attributed the dieoffs to a lungworm-pnemonia complex. This prompted a number of studies of lungworm (*Protostrongylus* spp.) infections in bighorn sheep.

Uhazy and Holmes (1971a and 1971b) intensively studies lungworm infections in Alberta bighorns, Stelfox (1971 and 1974) used the rate of lungworm infection as one indicator of population condition and to predict future die-offs.

Hibler et al. (1972 and 1974) studying a bighorn die-off in Colorado, found transplacental transmission of lungworm larvae caused high mortality in newborn lambs.

Forrester and Senger (1964) surveyed the lungworm infections in Montana sheep herds from 1958 to 1963. This work was updated by Worley et al. (1976). The results from this study (Stoneberg 1973 and 1974) and Stewart's (1975) were included in the summary by Worley et al. (1976).

Table 29 shows lungworm larval output determined from examining fecal samples collected from the Stillwater winter range.
Forrester and Senger (1964) reported a much higher larvae per gram (LPG) output in the Stillwater herd than was noted during this study. Worley et al. (1976) maintained these data may not be directly comparable; however, they indicated a decreased infection rate between the two studies.

Table 29. Incidence and intensity of lungworm *(Protostronglyus spp.)* infections in the Stillwater bighorn sheep herd as estimated by occurrence and rate of larval output in feces.

Year	No of Samples	% Infected	LPG 1/	Range	Source
1958-63	29	100	900 2/		Forrester & Senger (1964)
1971-72	11	100	72	0.3-668	Stoneberg (1973)
1972-73	26	89	11	0-194	Stoneberg (1973)
1973-74	22	91	8	0-30	Stoneberg (1974)
1974-75	104	91	6	0-125	Stewart (1975)
1971-75 AV.	167	92	11	0-668	Worley et. al. (1976)

1/ Larvae per gram of fecal material

2/ Data were presented as 90 larvae per 100 mg. dry feces.

Stelfox (1971 and 1974) found LPG outputs increased as range conditions deteriorated. Forrester and Senger (1964) studied the Stillwater herd during the period of intense forage competition with livestock and mule deer. The range was reportedly in poor condition (Foss 1967). In 1967 a fence was constructed increasing the quality of forage available to the sheep.

A small sample size of 1971-72 indicated a 100 percent infection rate with an average of 72 LPG output. The adult segment of the population increased during the course of this study. At the same time, the incidence of lungworm infection and larval output decreased (table 29). These data suggested fence construction may have improved the quality of Stillwater sheep range. They further indicated this herd was probably not stressed by environmental factors.

Smith (1954) claimed, "strong evidence of what now appears to have been Scabies epidemics in the late 1800's and early 1900's indicated that the infecting *Psoroptes* mite may have been largely responsible for the initial decline of mountain sheep herds." Cooney (1973) noted "scab" was a serious disease of sheep in the Beartooth Mountains up to the early 1930's.

In the spring of 1973, two tranquilized sheep (an old ewe, No. S4284, and a lamb, No. S4286) had considerable exudate and "wax" buildup in their ears. Scrapings from both sheep were sent to the Veterinary Research Lab in Bozeman,

Montana. Large numbers of psoroptic mites *(Psoroptes equi* variety *ovis)* were found in both samples (Worley pers. comm.). In December 1973 a ewe (No. S3543) was handled that had extensive scab formation around the anal region. Scrapings from this area and from her ears both revealed psoroptic mites.

The scabies infection in the Stillwater sheep herd did not appear to be serious. General observations, however, indicated hearing was severely impaired in individuals with heavy ear infections.

All sheep handled were infected, to varying degrees, with ticks *(Dermicentor albipictus)*. The ticks generally localized around the anus and along the back bone, particularly between the shoulder blades. The more severe infections caused hair loss, lesions, and scab buildup. However, the sheep did not appear to be stressed by the ticks.

Mining vs. Bighorn Sheep

The Stillwater bighorn sheep winter range was adjacent to a highly mineralized zone called the "Stillwater Complex." The Mouat property, adjacent to the winter range, had a long history of mineral exploration and development. During World War II and the Korean War this property was extensively developed for chrome ore production. Specific data were lacking to assess the impacts on the sheep herd.

The last major development occurred from 1952 to 1961. Counts during this period did not indicate a reduction in herd size. However, counts from the late 1960's suggested a reduction had occurred earlier in the decade. This implied mining did not directly reduce the herd but may have contributed to a gradual decline. Probably of greater importance was the intense forage competition with livestock and mule deer at this time.

The mine activity was on the steep, rocky, escape terrain that was used by sheep mainly in early fall and late spring. Since much of the activity was above the winter snow line or north of the main winter range, impacts on the herd were probably minimal.

The sheep also tolerated a considerable amount of human activity on and adjacent to the winter range. This was evidenced by their close association with the well traveled, all weather road (Hwy 419) cutting across the eastern edge of the winter range.

In addition the Beartooth ranch and a cabin on Verdigris creek were inhabited throughout the winter. The sheep were generally intolerant of humans in the fall, became less wary as winter progressed, and were again intolerant in late spring.

In 1975-76 a small group of rams segregated from the ewes after the breeding season. The rams spent most of the winter on the steep, rocky mineralized, northern edge of the winter range. This may signify a return to a historic ram winter range. Since it overlapped the area

of mineral development, this segment of the population could be adversely effected by future mining operations.

The critical aspect of this winter range was its relatively small size (2-3 square miles) (Pallister 1974; Stewart 1975). It appeared the major impact from mining would be physically removing portions of the range from use by sheep. This could be in the form of increased road construction, building sites, tailings piles, or strip mines. In order to provide adequate range for future bighorn sheep herds, no development should be allowed on Forest Service land south of Mountain View Creek below 6500 feet elevation.

Summer Range

Attempts to study the summer biology of the bighorn sheep herd wintering in the Stillwater valley met with little success.

The sheep began leaving the winter range in mid-May and reappeared around the first of October. From the few relocations of marked animals, it appeared they were ranging up the Stillwater River to Flood Creek. Some moved up Flood Creek to Rabbit Gulch and ranged south to Two Sisters mountain above the North Fork of Wounded Man Creek (Fig. 10).

Only one lambing ground was located. On June 21, 1974, three ewes were observed on the south face of Two Sisters mountain above Barrier Lake. On the 28th of June two lambs were observed in the same area with these ewes.

A portion of the herd returned to the winter range during the summer to use the salt on the Beartooth ranch. In 1974, two marked yearlings (Nos. 167 and 169) and one marked 2-year old ewe (No. 168) were last seen on the Mouat Mine roads on June 3. By June 21 they were part way up Flood Creek and by the end of July they were observed on the winter range. An adult ewe (No. S3543) was seen along Flood Creek on July 3. She was reported on the winter range on July 22 and on September 3 she was observed in the timber between the winter range and Flood Creek.

The sheep generally stuck to the rocky, timbered, south and east facing slopes and avoided the open plateaus. Their avoidance of open areas made observation extremely difficult.

One ram (No S4285), banded on the Stillwater winter range in March 1973, was reported on Sheepherder and Monument mountains in the summer of 1973. He returned to the Stillwater winter range later that year. In 1974, this ram was last observed along the Stillwater river on June 3. Tracks were noted crossing Columbine Pass in late June and on July 1 the banded ram was observed on Monument Peak. He was in the company of large rams that had never been observed in the Stillwater area. Also in the vicinity were unbanded ewes and lambs. He was reportedly still in this area in mid-October. On November 12 he was observed on the Stillwater winter range and was taken by a hunter on November 18, 1974.

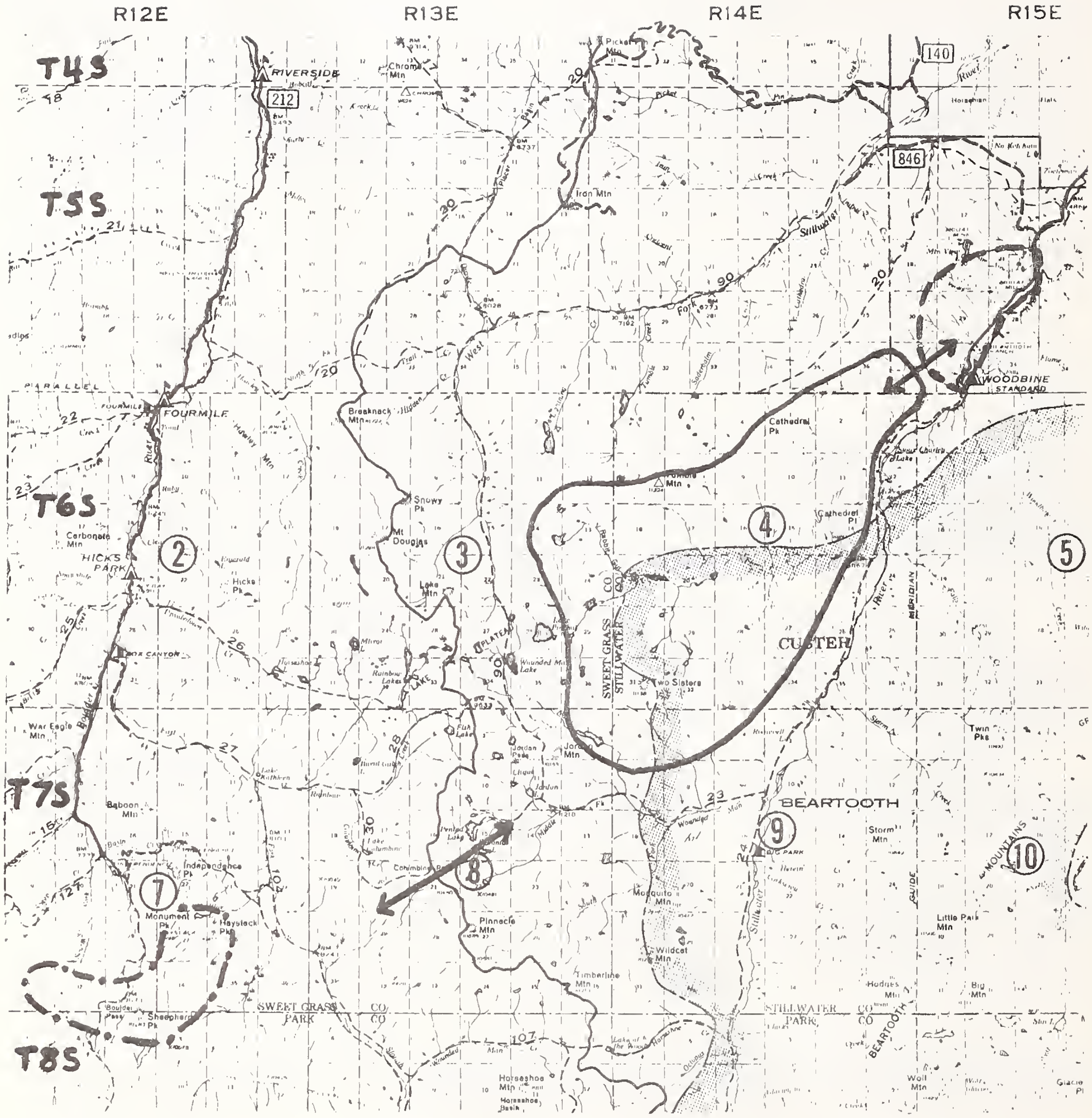


Figure 10. Location of summer range (______), winter range (------) and ram pasture (-.-.-.) for the Stillwater River bighorn sheep herd.

Another yearling ram (No. 96) was banded on the winter range on May 20, 1975. He was not seen during the summer of 1975 but returned to the winter range in 1975-76. He was sighted near the Boulder Pass (Sheepherder mountain) in the summer of 1976 (Simmons pers. comm.).

Apparently the summer range for rams wintering in the Stillwater valley was the Monument - Sheepherder mountains area at the head of the Boulder river.

The data suggested the summer range of ewes included the Stillwater River to Flood Creek, Cathedral Point, Rabbit Gulch and Two Sisters mountain (Fig. 10). It was possible, however, that ewes ranged west toward the Boulder River and south along the Stillwater River.

The summer range was used for only four months each year. Suitable looking terrain stretched for miles up the main Stillwater and along the side drainages. Availability of summer range did not appear to be a limiting factor. Also abundant food appeared to be available for this relatively small herd.

Stewart (1975) noted that horn growth, an indicator of range quality, was slightly greater on the Stillwater than the adjacent West Rosebud range.

By all appearances the summer range was adequate to satisfy the needs of the sheep herd. However, the data suggested considerable mortality occurred on this range. One marked ewe (No. 168) was known to have died during the summer and several failed to return to the winter range (Table 22). The data in Table (25) indicated yearling survival through the second summer was occasionally quite low. The reasons for these losses were unknown. However, it was possible some of the apparent mortalities had simply moved to a different winter range.

Proposed mining activities on and adjacent to the Stillwater Complex should have little or no impact on the bighorn sheep summer range.

Summary

The sheep spent approximately eight months of each year on the two to three square mile winter range which was located along the west side of the Stillwater River from the old Mouat Mill to Woodbine trail-head.

Between 30 and 50 sheep have used the same winter range at least since the early 1900's.

Sheep numbers declined in the 1960's and increased in the 1970's. Severe range competition with domestic horses and mule deer occurred through the 1950's and early 1960's. In 1967 a fence was constructed preserving a portion of the range for wildlife.

The Mouat mine operated from 1952 through 1961 and may have contributed to the decline. In 1968 and 1970, four rams from the Sun River area were released on the Stillwater winter range.

Age ratios, increased from an average of 29 lambs/100 ewes in the 1950's and 1960's to 61 lambs/100 ewes in 1971-72. It further increased to 64 in 1972-73 then steadily declined to 32 in 1975-76.

The fence construction probably had the greatest impact on the increased production and/or survival of lambs in the early 1970's. Varying lamb survival and yearling recruitment acted to stabilize the population at about 45 sheep.

Forage quality and quantity studies indicated food was not a limiting factor.

Lungworm larvae outputs were indicative of a healthy, thriving population.

Apparently the decreased production and/or survival rates were due to the small size of the winter range. This herd may have been responding to density dependent factors. It appeared 40 to 50 sheep was the carrying capacity of this range.

The breeding season extended from mid-November through mid-January. Although all age classes were observed chasing ewes, only 3½ year old rams were observed successfully copulating.

The summer range for rams was at the head of the Boulder River on Sheepherder and Monument Mountains. The ewes summered along the main Stillwater River and along the side drainages, Flood Creek and Wounded Man Creek.

MULE DEER

History

Historically mule deer populations in the Beartooth Mountains fluctuated in numbers (Fig. 11) similar to other herds in Montana (Egan 1971).

In 1925, McLean (1930) estimated there were only 585 mule deer on the Beartooth Division of the Custer National Forest. This number increased to 1090 by 1929. The increase was attributed to the introduction of the " buck law " in 1921, the closing of Carbon County to all hunting in 1925, more rigid law enforcement and predator reduction.

By 1935-36, 1200 mule deer were estimated wintering on the Beartooth Division. The Stillwater District carried 711 of these. A major concentration area was identified along the main Stillwater River near the Beartooth ranch. An estimated 100 mule deer wintered on this 2-square mile area (Cooney 1936).

The population estimate increased to 1365 for the winter of 1936-37 (Cooney 1937). The number on the Stillwater District decreased to

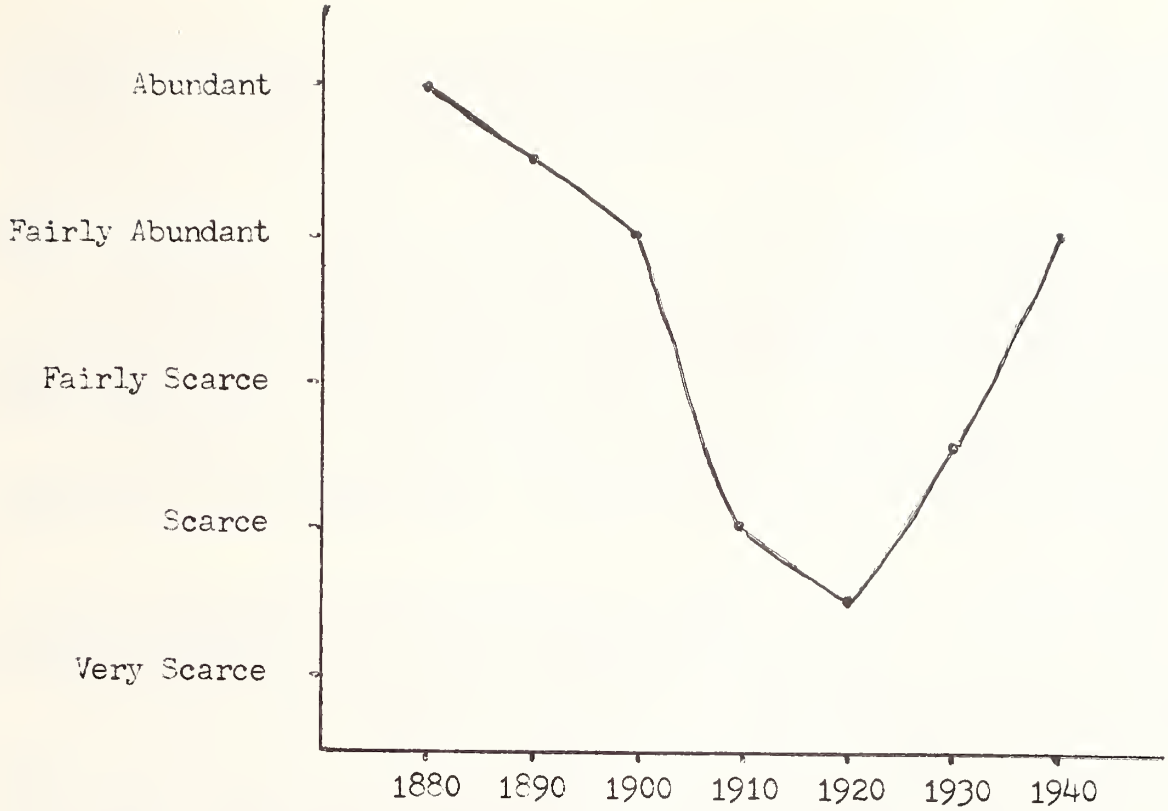


Figure 11. Historical population curve for mule deer in the Beartooth Mountains, 1880-1940 (Cooney 1937).

Picket Pin wildlife-livestock exclosure plots. Total exclosure plot in center of picture, livestock exclosure on the left and control plot on the right. Dark vegetation in total exclosure plot was horizontal juniper.

683. However, the main Stillwater River was still considered a major concentration area. Damage from overbrowsing was reported on this range from the lower end of Sioux Charley Lake to the mouth of Nye Creek.

The mule deer populations continued to increase through the 1940's. Forest Service estimates for the Stillwater district were 2500 in 1944, 3500 in 1945, and 4000 in 1946. In 1945, the Upper Stillwater Livestock Association requested assistance from the Montana Department of Fish and Game to alleviate deer damage to haystacks. They estimated at least 600 head of deer were using the haystacks in the Limestone, West Fork of the Stillwater River and Picket Pin areas. Although the accuracy of these estimates may have been questionable, they indicated mule deer numbers increased considerably in the late 1930's and early 1940's.

The U.S. Fish and Wildlife Service began using 1080 for coyote control in 1947. Although the resulting reduction of predators probably gave the deer herds an additional boost, it was apparent mule deer were becoming a problem prior to the use of 1080.

The Montana Department of Fish and Game responded to the increasing deer populations by authorizing a short either-sex hunting season in 1949. In 1950 a three day (Oct. 15-17) either-sex season yielded the following harvest: 97 adult males, 157 adult females, 145 fawns, total 399 (Fitzwater et al. 1951). The following spring (April 1951), 766 deer were censused in the Stillwater area (Fitzwater et al. 1951).

In 1951 a one week (Nov. 1-7) either sex season followed two weeks of bucks only hunting. Four hundred and sixty-eight deer were brought through a game check station during the hunter's choice season (Gaab 1952b). The data indicated 60 percent of the kill was 1½ years old or younger which led to the conclusion, "The Nye (Stillwater) deer are a vigorous, healthy, highly productive herd...optimum utilization is being made of the Nye herd annually and the better range management will perpetuate a larger number of harvestable game over a period of years." (Gaab 1952b).

The 1952 Montana Fish and Game reports mentioned the mouth of the Stillwater Canyon was closed to big game hunting. The closure was probably associated with the reopening of the Mouat Mine. Deer were reportedly, "in poor condition and competing with mountain sheep on an overused range in the present closed area" (Gaab 1952a). The area was recommended opened to deer hunting during the 1952 season.

A three day either sex deer season was held during 1953. A total of 260 deer were harvested from the Stillwater area (Gaab 1954).

By 1954 mule deer were considered "the biggest wildlife problem on the Beartooth range" (Lentfer 1954). An extended either sex hunting season was held along the West Fork of the Stillwater River from November 1 through December 20.

Major changes were introduced in the 1955 hunting season. The general deer season was changed from bucks only to either sex for more than half of Montana (Mussehl and Howell 1971). The Stillwater season was further liberalized by a nonfixed closing date and by the issuance of 1000 special permits. Apparently the permits entitled the holder to two deer and/or taking a deer after the regular season.

The first general two deer, either sex, season was introduced in 1956. In 1957, special nonresident $20.00 deer permits were available for the Stillwater area. Special late seasons were held in 1960 (Dec 4-18), 1961 (Dec 3-24), and 1962 (Dec 2-23).

In 1963 and 1964 no special nonresident permits were available and no late seasons were held.

In 1965, 200 nonresident permits were issued. The number was increased to 600 in 1966 and a late season was held. A late season in 1967 was limited to Forest Service lands only.

The 1968 season was the last special late hunt held in the Stillwater area. Beginning in 1967 the special nonresident permits were split into two groups of 300 each. One group could hunt the entire season (except in 1967) while the other group was limited to the latter part of the season.

In 1973 and 1974 one of the two deer taken from the Stillwater area (B tag) had to be antlerless. In addition, 300 of the special nonresident permits were for antlerless deer.

In 1975 only one deer of either sex was allowed and no special nonresident permits were issued. The mule deer season was further restricted to one antlered buck per hunter in 1976. In addition, 250 either sex permits were issued.

The progressive change from restricted through liberal and back to restricted hunting seasons probably reflected the population curve of the deer herds.

Harvest Data

Deer harvest data for Hunting District 52 (Fig 12), which included the Stillwater valley, were available from the Columbus opening day check station and from hunter questionnaire returns.

Harvest data from the Columbus check station (Table 30) varied considerably between years but no major trends were indicated. To reduce the yearly variation, three-year averages were computed. The percent of fawns in the three year average harvest declined gradually from 22 percent to 13 percent. This was offset by an increased harvest of yearling males. The percent of adults killed remained fairly stable, except during the 1967-69 period.

Table 30. Age and sex classifications and hunter success data collected on the opening day of the general deer season at the Columbus check station. Includes deer taken in Hunting District 52 (Stillwater) and surrounding districts.

	Fawns (%)1/			Yearlings (%)			Adults (%)			Total(%)		Uncl.	Hunter	Total Number
	♂	♀	Tot.	♂	♀	Tot.	♂	♀	Tot.	♂	♀	(No)	Success (%)	Deer
1951 2/	17	18	35	13	13	26	6	33	39	36	64	149	30	468
1955 3/	7	10	17	35	17	52	8	22	30	50	49	37	--	241
1957 4/	9	11	20	26	10	36	17	26	43	52	47	12	37	99
1962	11	11	22	29	9	38	25	15	40	65	35	5	27	60
1963	11	13	24	11	11	22	19	35	54	41	59	--	28	37
1957-63 Av.	10	12	22	22	10	32	20	25	45	52	47		31	65
1964	6	11	17	36	16	52	20	10	30	62	37	8	46	106
1965	5	8	13	19	10	29	34	24	58	58	42	10	31	94
1966	9	13	22	31	8	39	16	23	39	56	44	--	35	141
1964-66 Av.	7	11	18	29	11	40	23	19	42	59	41		37	114
1967	17	5	22	49	7	56	8	14	22	74	26	--	28	87
1968	5	5	10	54	14	68	17	5	22	76	24	22	33	127
1969	6	10	16	33	10	43	16	25	41	55	45	7	40	88
1967-69 Av.	9	7	16	45	10	55	14	15	29	68	32		34	101
1970	8	4	12	40	9	49	24	15	39	72	28	11	42	103
1971	5	7	12	35	8	43	25	20	45	65	35	7	77	145
1972	3	12	15	33	8	41	29	15	44	65	35	9	34	75
1970-72 Av.	5	8	13	36	8	44	26	17	43	67	33		51	108

1/ All values are a percent of the total number of deer classified.
2/ Data from check station in Upper Stillwater during a 7 day either-sex hunt (Gaab 1952b).
3/ Data from Columbus check station operated for 3 days during the general deer season (Ellig 1956).
4/ Data from Columbus check station operated for 3 days during the general deer season. Hunter success and total number of deer were for opening day only (Lovaas 1958).
Note: Includes both mule deer and whitetailed deer. Mule deer generally contributed 90%+ to the harvest.

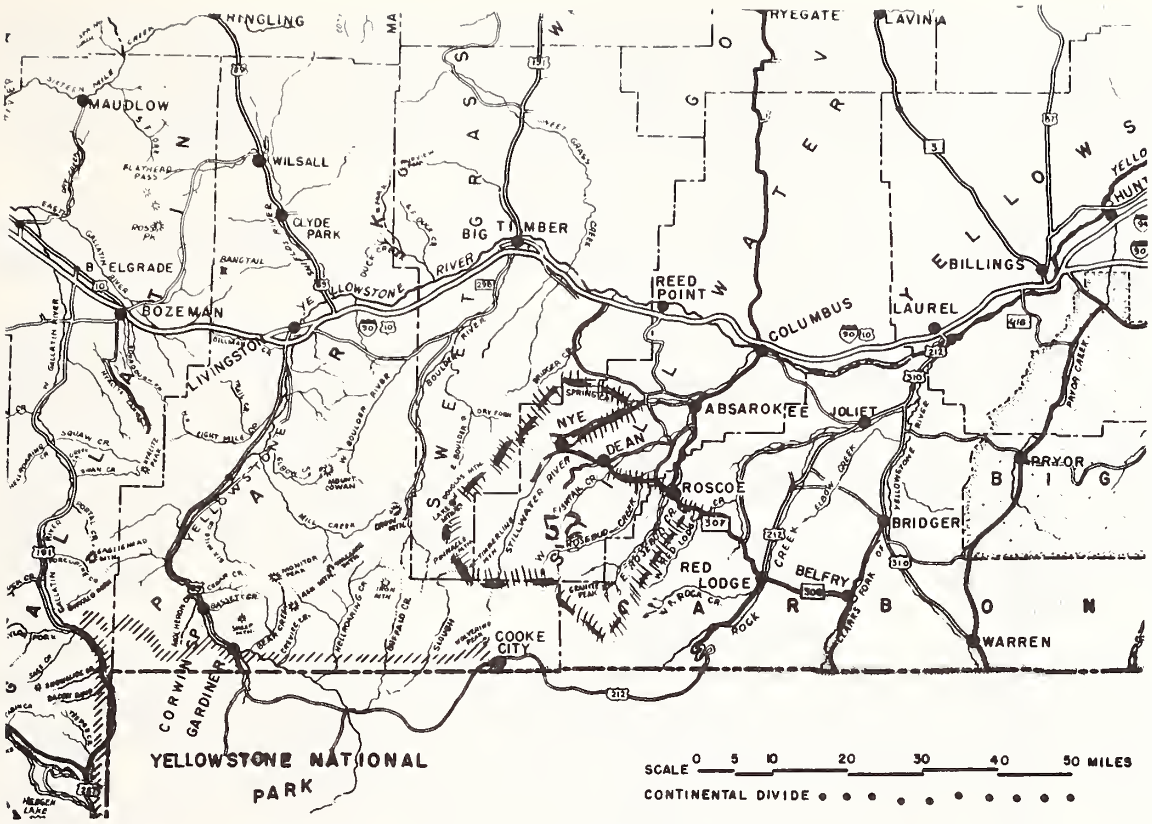


Figure 12. Location of deer hunting district 52 (changed to 520 in 1973).

Checking mule deer use on big sagebrush plants on the Stillwater winter range.

The sex ratio of the kill shifted over the years to favor males. The percent of antlered bucks (yearling and older) taken increased from 42 percent (1957-63 average) to 62 percent (1970-72 average). This probably reflected hunter selection but it may have indicated a shift in the sex ratio of the general population.

The number of deer checked and hunter success varied between years but no trend was detected.

Although subtle changes in the sex and age ratios were noted, the check station data did not indicate the deer populations were declining.

Beginning in 1959, questionnaires were sent to a representative sample of deer hunters. The total kill and number of hunters in each hunting district were estimated from the returns. Sampling techniques and data presentation varied somewhat over the years. This was compensated for in Table 31.

The number of deer hunters using Hunting District 52 varied considerably between years from 1959 to 1969. Starting in 1969, the number of hunters increased progressively to a peak of 4594 in 1973 and then declined. The number of deer killed also fluctuated greatly until 1969. The kill increased gradually from 1317 in 1969 to 2466 in 1973 and then decreased to a low of 699 in 1975.

From 1959 through 1970 hunter success varied from 54 percent to 99 percent and averaged 74 percent. Success steadily declined after 1970 to a low of 34 percent in 1975.

The large drop in deer harvested between 1974 and 1975 was partially due to the change from a two deer season to a one deer season. In 1974, 468 deer (28 percent of the total harvest) were taken with a "B" tag. However, this would not explain the decreased success.

Although the mule deer populations were probably declining through the 1960's, their numbers were high enough to ensure at least three quarters of the hunter success. It was not until the 1970's that populations dropped low enough to be manifest in reduced hunter success ratios.

Vegetation

As mule deer numbers increased through the 1940's and 1950's, overuse of the range was reported. In 1935-36 close cropping of browse was noted on the Stillwater winter range (Cooney 1936). Damage from overbrowsing was also observed in 1936-37 (Cooney 1937). A range survey in 1954 gave the following report for the Stillwater area (summarized from Lentfer 1954):

Below Nye - moderate deer numbers, no browse

Myers Creek - the small amount of browse that is available showed definite overuse. Chokecherry showed severe overuse.

Castle Creek - sagebrush, juniper and chokecherry received heavy past and current use. Some juniper and chokecherry had been killed.

Picket Pin Creek - sagebrush and juniper are the predominant browse species. Sagebrush had severe use and many of the plants were dead. Juniper was overused.

Table 31. Number of deer hunters, harvest and hunter success in Hunting District 52 (changed to 520 in 1973) as determined from the Hunter Questionaire, 1959-1975.

Year	No. Hunters 1/	Deer Taken 2/	% Success
1959	1377	1061	77
1960	2459	2483	99
1961	3079	2429	79
1962	3011	2284	76
1963	1802	1209	67
1964	3335	2578	77
1965	1987	1068	54
1966	3345	2263	68
1967	2391	1811	76
1968	2507	1682	67
1969	1818	1317	72
1970	2243	1650	74
1971	2801	1776	63
1972	3919	1883	48
1973	4594	2466	54
1974	3788	1681	44
1975	2036	699	34

1/ Each deer tag was considered one hunter (i.e., if a person hunted in H.D. 52 with an 'A' tag and a 'B' tag he was considered two hunters). Prior to 1971 this corresponded to Hunter Units. Includes resident, regular nonresident and special permit nonresident hunters.

2/ Includes both mule deer and whitetailed deer. Mule deer generally contributed 90%+ to the harvest.

Main Stillwater above Nye - browse species received heavy past use and moderate to heavy current use.

It was not until 1955, however, that the first vegetation transects were established in this area. Three sets of paired ground cover and browse intercept transects were read on Meyers Creek and Picket Pin Creek mule deer winter ranges (Tables 32 & 33). The transects were re-examined in 1960 and 1965.

Table 32 indicates total ground cover did not change over the ten year period. In Meyers Creek (transects located on a beef pasture) browse stayed about the same, grass declined and moss and lichens increased. The browse declined on one Picket Pin transect and increased on the other. The converse was true for grasses.

Table 32. Point - intercept vegetation trend surveys of Meyers Creek and Picket Pin mule deer winter ranges. (U.S. Forest Service-Mont. Dept. of Fish and Game cooperative study).

	Meyers Creek			Picket Pin I			Picket Pin II		
	10/55 1/	9/60	9/65	10/55	9/60	9/65	10/55	9/60	9/65
Browse	56 2/	58	53	43	34	23	16	22	25
Grass	8	4	2	7	9	14	32	11	12
Forbs	1	0	0	1	2	4	1	0	2
Litter	23	22	24	24	33	32	30	37	33
Moss & Lichens	0	4	6	9	5	10	0	6	8
Ground Cover Index	88	88	85	84	83	83	79	76	80
Rock	8	7	4	5	7	8	2	2	5
Bare Soil	3	5	10	10	10	9	19	22	14
Erosion pavement	0	0	1	0	0	0	0	0	1

1/ Date transect read.

2/ Total number of hits on two 50' transects sampled every foot.

Table 33. Ten year browse intercept trend data from Meyers Creek and Picket Pin mule deer winter ranges. (U.S. Forest Service-Mont. Dept of Fish and Game cooperative study).

Species	Meyers Creek			Picket Pin I			Picket Pin II		
	10/55[1]	9/60	9/65	10/55	9/60	9/65	10/55	9/60	9/65
Artemisia tridentata	48.4[2]	57.0	52.4	19.9	13.2	16.9	7.3	16.1	23.9
Juniperus horizontalis	--[3]	--	--	26.2	19.4	4.6	1.1	0.5	--
Rosa spp.	--	--	--	--	0.1	--	--	--	--
Pseudotsuga menziesii	--	--	--	--	--	2.5	--	--	--
Artemisia frigida	--	--	--	--	--	--	0.4	0.7	--
Total:	48.4	57.0	52.4	46.1	33.7	24.0	8.8	17.3	23.9

1/ Date transect read (month/year).

2/ Total inches from two 50' transects.

3/ No values given.

Table 33 separated the browse component by species. On Meyers Creek, big sagebrush, the only browse species recorded, increased slightly during the ten years. The major change in browse on the first set of Picket Pin transects was an 82 percent decrease in juniper. The small amount of juniper on the second set of Picket Pin transects also declined. However, big sagebrush increased by 227 percent from 1955 to 1965.

In December 1961 a set of exclosures were constructed on the Picket Pin mule deer winter range. Juniper transects were periodically read over the next 12 years (Table 34). The juniper showed a continuous decline in both the control (no fence) plot and the livestock excluded plot. In the deer and livestock excluded plot, however, the juniper increased. This suggested mule deer caused the decline.

These data indicated mule deer fed heavily on juniper in the Picket Pin area. They also indicated this species could be used to measure range conditions and population pressures on this winter range.

Table 34. Trend data on *Juniperus horizontalis* in the Picket Pin deer and cattle exclosure study.1/

	Plot Type					
	Control		Livestock Excluded		Deer-livestock Excluded	
Year	Hits(%)	Misses(%)	Hits(%)	Misses(%)	Hits(%)	Misses(%)
1961	64	36	--	--	76	24
1962	61	39	43	57	81	19
1963	52	48	40	60	81	19
1964	--	--	--	--	--	--
1965	51	49	39	61	80	20
1972	32	68	30	70	84	16

1/ Each study plot consisted of 100 linear feet with a point measurement taken every 0.5 feet. Live plant crown was recorded as a hit; a miss was either dead crown or the absence of juniper at the point.

Permanent juniper transects were established on Horseman Flats in 1959 (Table 35). In general, the condition trend was downward through the early 1960's. Considerable improvement was noted on the two transects read in 1972. However, they declined again in 1973.

Table 35. *Juniperus horizontalis* trend data from three point intercept transects on and adjacent to Horseman Flats. (Mont. Dept. of Fish and Game files).1/

	Plot Number							
	406		408		409		Av. Hits(%)	
Year	Hit(%)	Miss(%)	Hit(%)	Miss(%)	Hit(%)	Miss(%)	All	408+409
1959	56	44	37	63	67	33	53	52
1961 2/	51	49	33	67	66	34	49	50
1962	50	50	30	70	57	43	44	44
1963	52	48	28	72	59	41	45	44
1965	49	51	28	72	52	48	43	40
1966	46	54	30	70	51	49	42	41
1972	--	--	39	61	68	32	--	54
1973	4	96	33	67	60	40	32	47

1/ Each study plot consisted of two 100 linear feet lines. Point measurements were taken every 0.5 feet. Live plant crown was recorded as a hit; a miss was either dead crown or the absence of juniper at the point.
2/ Only 100 feet were sampled on plot 406 from 1961 to 1963.

These transects were on the fringe of the mule deer winter range. Snow depths precluded use of this area during much of the winter. Few deer were observed wintering on or adjacent to the transects in 1974-75 and 1975-76. The heaviest use occurred in the spring when other forage species were available.

Data from these transects should be interpreted cautiously. An increase in use could signify a buildup in the deer herds resulting in heavier use of the fringe areas. On the other hand, it could be due to a mild winter with low snow fall allowing the deer to utilize these areas.

Transect 406 was located on a ridge northwest of the West Fork of the Stillwater River. This ridge was heavily used by mule deer during the winter. Through the early 1960's the amount of live juniper decreased at a similar rate as the two transects on Horseman Flats. Between 1966 and 1973 the percent of live hits decreased from 46 to 4. Dead crown accounted for 25 percent of the misses on plot 406 in 1973 compared with 4 and 8 percent on plots 408 and 409.

Transect 406 was more representative of heavily used mule deer winter range than transects 408 and 409. Apparently continuous heavy use severely diminished the juniper on this range.

These transects should be maintained to monitor changes caused by proposed mineral development in this area.

The first permanent browse transects along the main Stillwater River were established in 1967. Twenty-five big sagebrush and 25 skunkbush sumac plants were inspected on the winter range near the Beartooth ranch, south of the Old Mouat mill. The methods followed were described by Cole (1963).

The big sagebrush plants indicated the range was in "very poor" (i.e. more than 50 percent of the plants severely hedged or decadent) condition when the transect was established. No improvement was noted through 1974 (Table 36).

Discrepancies in the skunkbush sumac data (Table 37) were probably due to difficulties encountered adopting Cole's (1963) methods to this species. The skunkbush sumac was generally classed as "poor" (i.e. 31-50 percent severly hedged or decadent) and showed no improvement.

Mule deer populations in the upper Stillwater Valley increased during the 1930's and 1940's and probably peaked in the 1950's. The permanent vegetation transects were established after many years of range abuse by an apparently overabundant deer population. Therefore, no baseline data existed to determine vegetative changes prior to and during the buildup.

Production and Survival

Production figures, comparable from one year to the next, were not available for mule deer populations in the Stillwater valley. Winter

Table 36. Condition and trend of big sagebrush *(Artemisia tridentata)* on a mule deer winter range in the Upper Stillwater Valley. (Transect No. 499).

Year	Form Class (%)1/ 3 & 6	Age - Mat.	Class %2/ Dec.	% Crown Area Dead	% Leader Use
1967	80	12	88	53	58
1968	Not Read				
1969	84	20	80	34	82
1970	60	36	64	37	80
1971	64	24	76	42	61
1972	88	36	56	39	53
1973	88	24	76	47	80
1974	68	16	84	51	65
1975	Not Read				

1/ Form class 3 - all available, severely hedged (Cole 1963).
Form class 6 - partially available, severely hedged.

2/ Age classes: Seedling, Young, Mature, Decadent.

Table 37. Condition and trend of skunkbush sumac *(Rhus trilobata)* on a mule deer winter range in the upper Stillwater Valley. (Transect No. 499).

Year	Form Class (%)1/ 3 & 6	Age - Mat.	Class % 2/ Dec.	% Crown Area Dead	% Leader Use.
1967	36	76	24	19	22
1968	Not Read				
1969	48	64	36	23	56
1970	28	76	24	18	45
1971	36	32	68	34	54
1972	56	32	68	33	42
1973	40	72	28	18	46
1974	16	44	56	26	28
1975	Not Read				

1/ Form class 3 - all available, severely hedged (Cole 1963).
Form class 6 - partially available, severely hedged.

2/ Age classes: Seedling, Young, Mature, Decadent.

classifications, which included production and survival, were periodically conducted.

Age classification data for areas that included the Stillwater valley were summarized in Table 38. Extremely low fawn per 100 adult ratios were observed in the Beartooth Mountains from 1925 through 1928 (McLean 1936). By 1929 the ratio had increased to 20 fawns/100 adults. Comparable ratios were 29 in 1935-36 (Cooney 1936) and 42 in 1936-37 (Cooney 1937).

These data indicated production and/or survival only increased from "very poor" to "poor" (ratings based on fawn/100 does, Gordon and Coop 1973) during the period when deer populations were building.

No herd composition counts were recorded for the 1940's and 1950's. By 1961-62 the fawn/100 does ratio was rated "fair". It remained at or near this level through 1963-64 then dropped to "poor".

The production rating was "poor" through the latter 1960's. In 1969-70 a large sample indicated an increase to 42 fawns/100 adults. In 1972-73 production and/or survival was listed "fair". It has progressively decreased since.

Herd composition counts conducted during the course of this study, from 1972-73 through 1975-76, recorded a similar trend (Table 39). For all deer classifications, the fawns/100 adults ratio decreased from 50 in 1972-73 to 20 in 1975-76. Counts from three separate winter ranges (Table 39) indicated the decline was widespread.

The limited herd composition data did not establish a strong relationship between production (and/or fawn survival) and population changes. Counts in the 1930's were not indicative of an increasing population. Although no classifications were available from the building period of the 1940's and 1950's doe-fawn ratios peaked at only "fair" in the early 1960's. Assuming deer numbers peaked in the late 1950's and early 1960's then the subsequent lower age ratios may have resulted from overcrowded ranges and may have contributed to the decline in numbers. These data, supported by age ratios from the adjacent Boulder River area, indicated fawn survival through their first winter was generally low in these mountain deer herds.

There was no correlation between hunter success and the following winter adult-fawn ratios nor between hunter success and the preceding winter adult-fawn ratios.

Winter Range

The upper Stillwater valley provided suitable winter range for a large number of mule deer. The deer utilized most areas below approximately 7000 feet elevation. Above this, snow depth was a limiting factor. Major concentration areas included, Benbow, main Stillwater, Horseman Flats and Picket Pin-Castle Creek.

Table 38. Winter age and sex ratios of mule deer classified in areas which included the Stillwater valley.

Year	No. Deer Classified	Fawns/ 100 Ad.	Fawns/ 100 Does	Bucks/ 100 Does	Area Censused
1925	380	2	2	12	- Beartooth Div. Custer N.F.
1926	218	0	0	16	- Beartooth Div. Custer N.F.
1927	76	9	10	21	- Beartooth Div. Custer N.F.
1928	284	8	9	21	- Beartooth Div. Custer N.F.
1929	201	20	23	16	- Beartooth Div. Custer N.F.
1935-36	711	30	41	37	- Stillwater Dist. Custer N.F.
1936-37	373	34	46	34	- Stillwater Dist. Custer N.F.
1961-62	--	--	66	--	- Hunting Dist. 52
1962-63	--	--	59	--	- Hunting Dist. 52
1963-64	316	57	--	--	- Hunting Dist. 52 (Spring counts)
1964-65	--	36	53	47	- Hunting Dist. 52
1965-66	179	33	42	30	- H. D. 52
1966-67	164	36	43	17	- H. D. 52
1967-68	467	37	40	6	- H. D. 52
1968-69	63	37	--	--	- H. D. 52 (Spr. cts)
1969-70	2241	42	--	--	- H. D. 52
1970-71	577	33	--	--	- H. D. 52
1971-72	288	38	--	--	- H. D. 52
1972-73	399	58	73	6	- H. D. 52
1973-74	1112	48	--	--	- H. D. 520
1974-75	1076	32	38	26	- H. D. 520

Table 39. Age classifications of Mule Deer Wintering in the upper Stillwater Valley. 1972-73 - 1975-76.

Total Area

Year	Ad	Fawns	Fawns/100 Ad	Time Period
1972-73	72	36	50	(Jan - Feb)
1973-74	388	173	45	(Feb - May)
1974-75	530	199	38	(Sept - May)
1975-76	422	85	20	(Jan - March)

Stillwater Bighorn Sheep Winter Range

Year	Ad	Fawns	Fawns/100 Ad
1972-73	72	36	50
1973-74	158	71	45
1974-75	327	118	36
1975-76	268	54	20

Horseman Flats - West Fork Stillwater

Year	Ad	Fawns	Fawns/100 Ad
1973-74	56	28	50
1974-75	41	16	39
1975-76	34	7	21

Picket Pin

Year	Ad	Fawns	Fawns/100 Ad
1973-74	174	74	43
1974-75	29	14	48
1975-76	93	17	18

Moderate to light snowfall coupled with strong chinook winds resulted in low snow packs during most winters. The Lower Picket Pin snow course was representative of the accumulated snow pack on the winter range (Table 9). The middle course, at 7250 feet, represented snow packs prohibitive to mule deer (Table 10). In general the deer were restricted to the winter ranges from December through April. Heavy late spring snow storms often presented hardships to the deer herds.

Distinct areas of concentration were difficult to define. Most observations were made during the feeding period (late morning and early evening) or following heavy snow storms. Mule deer were frequently observed feeding below the old Benbow Mill. They used both sides of the Stillwater valley up to the Woodbine trailhead. The west side (east facing slope), however, received the heaviest use.

Deer concentrated along the timbered edges of Horseman Flats and in the open timbered breaks along the West Fork of the Stillwater River. Again the east facing slope was heavily used.

Mule deer were found on most exposed slopes and valley bottoms west and north of the West Fork.

Six mule deer were trapped and neck banded on the bighorn sheep winter range in the upper Stillwater valley. Two fawns were ear tagged only.

One adult doe (S2298) was observed on the winter range on May 4, 1973. She was resighted on October 15, 1973 along Slough Creek in Yellowstone National Park. This represented a movement of approximately 28 air miles. She returned to the Stillwater winter range by December 17, 1973 and remained in this area through April 1974. On October 4, 1974 she was again sighted in Yellowstone National Park. During the winter of 1974-75 an unconfirmed sighting of this doe was made along the Stillwater River approximately 2 miles north of the bighorn sheep winter range. She was relocated in this area in the spring of 1976.

One adult male (S4283) returned to the winter range the year following banding. He was not seen in subsequent winters.

An adult female (S2299) was sighted on the bighorn sheep winter range in each of the three winters following banding. She was last seen on May 5, 1976.

Two bucks trapped and banded on Horseman Flats in 1973-74 were never resighted in succeeding winters.

One adult doe (171), trapped and banded on the Picket Pin winter range on April 13, 1974, was reobserved near the trap site on May 17, 1976. She had lost her neck band and was identified by her plastic ear tag number.

On March 26 and 30, 1976 a neck banded mule deer (No. 13) was observed on the Picket Pin ranch (Sec. 31, R15E, T4S). Banding records

revealed she was an adult doe when banded on February 28, 1974 in the main Boulder drainage near Graham Creek (Gordon, Coop and Denton 1974). She was observed near the banding site in April and May 1975. The Picket Pin sighting was approximately 14 air miles from the trap site.

The limited data from a few marked animals gave an insight into the complex movements of these mountain mule deer herds.

Relations between summer and winter ranges and interactions between separate herds on the winter ranges have yet to be determined. These will be necessary before meaningful production data, effects of land use changes and the general population dynamics of these herds can be established.

Food Habits

Mule deer winter food habits were studied in 1974-75 (Stoneberg 1975). Stewart (1975) also recorded mule deer plant use and preference on the bighorn sheep winter range in the Stillwater canyon in 1974-75. The diet varied according to the availability of browse plants.

In the Picket Pin area, juniper was the dominant food item. Big sagebrush was also heavily used. Little use was noted on the dominant shrub ninebark.

Juniper was the dominant food item along the upper edge of Horseman Flat. Aspen and willow were taken when encountered. Very little use was noted on the abundant shrubby cinquefoil. On the open flat, where shrubs were rare, the deer fed on the dried heads and leaves of arrowleaf balsamroot and the dried remains of a tall lupine.

One feeding site, in two to three feet of snow, was examined along the West Fork of the Stillwater River. The deer were feeding in the snow-free areas under the large Douglas-fir and limber pine trees. Considerable use was noted on fringed sage, Idaho fescue, juniper, and Douglas-fir needles.

Skunkbush sumac was the main browse species on the east facing slope of the Stillwater valley. Chokecherry and big sagebrush were taken when encountered. Stewart (1975) also listed skunkbush sumac as the main item in the mule deer's diet. Other components of the diet were big sagebrush, chokecherry, common and horizontal juniper, fringed sage, arrowleaf balsamroot, golden aster and phlox.

Mule deer food habits were studied along the Boulder River in the winter of 1973-74 (Gordon, Coop and Denton 1974). Five rumen samples from the Douglas-fir zone contained, 45 percent grass, 7 percent forbs, 16 percent shrubs and 30 percent trees. Fringed sage was the dominant forb, Oregon grape and Rocky Mountain juniper the main shrubs and Douglas-fir the main tree species in these rumen samples.

In the same winter, three feeding sites in the Douglas-fir zone recorded 36 percent grass, 23 percent forbs, 17 percent shrubs and 24 percent trees. Only a trace of use on fringed sage was noted; the majority of the forbs were unidentified. The most heavily used shrub was common juniper and Douglas-fir was the only tree used.

Gordon et al. (1974) noted this range sustained heavy deer use in the past and that many key browse species were reduced or lacking. They concluded the mule deer diet along the Boulder River was marginal.

For comparison, the Picket Pin deer food habits were 1 percent grass, trace of forbs, 94 percent shrubs and 5 percent trees. On the main Stillwater the breakdown was 0 percent grass, 1 percent forbs, 99 percent shrubs and 0 percent trees (Stoneberg 1975). Stewart (1975) recorded feeding data along the main Stillwater according to habitat type. The range of major components was 0-1 percent grass, 0-38 percent forbs, 61-100 percent shrubs and 0-15 percent trees. Apparently these winter ranges were in better condition than those along the Boulder River.

Skunkbush sumac was the major component in the diet of the Stillwater mule deer. Little use, however, was noted on this common shrub in the Boulder River drainage. Martin (1972) contended this shrub was low in nutritional value in the winter and was generally used when other more palatable species were unavailable.

Land Use Changes

The effects of changing land use patterns on mule deer populations was difficult to assess. Little data were available to monitor changes in the deer herds. Thus cause and effect relationships could not be determined.

The last major forest fires swept through the Beartooth mountains in the 1890's. Extensive stands of lodgepole pine now occupy these sites. Modern fire suppression techniques have effectively eliminated this natural form of habitat manipulation. The fires probably increased the available browse and contributed to the buildup of the deer populations.

Around the turn of the century large herds of domestic sheep and cattle grazed the foothills and plateaus of the Beartooth mountains. Considerable overgrazing was documented in Forest Service range inspection reports. The browse species may have benefited from this heavy use.

Through the 1900's sheep were gradually replaced by cattle. The sheep population in Stillwater county decreased from 92,120 in 1913 to 21,864 in 1963 and the cattle increased from 8,083 to 35,102 (Annin 1964). All forest service grazing allotments experienced reductions in numbers and season lengths from 1920 to the present. While management direction was aimed at improving and increasing grass production, large numbers of mule deer were severely hedging the browse species. As a result, browse in many areas declined.

The scenic Stillwater valley attracted a small number of summer residents for many years. Recently, however, the construction of summer homes increased dramatically. Developers, hoping to cash-in on this demand for recreational homes, subdivided many acres of prime deer winter range. The present satiated market has not removed the potential for extensive damage.

Since most of the cabin use occurred during the summer months, the damage resulted from physically removing habitat by road and building construction. This will become increasingly apparent as more cabins are built.

The Stillwater valley periodically experienced extensive mineral development.

At least two companies may develop their holdings sometime in the future. The Anaconda Company controls the chrome, nickle and copper deposits of the Mouat and Benbow properties and have stated a major mine was a possibility in eight to ten years. They also own a ranch in the Stillwater valley about 10 miles northeast of the mineral zone. If this mine were developed, road and building construction and settling ponds would reduce the available mule deer winter range. A major impact would be from the influx of workers and accessory personnel requiring living quarters in the Stillwater valley. This would probably result in more subdivisions on mule deer winter range.

The Johns-Manville Sales Corp. began construction of an exploration adit (tunnel) along the West Fork of the Stillwater River in 1974. In the same year they purchased the Picket Pin ranch which borders the Forest Service approximately 4 miles northeast of the adit. The company announced plans to open a platinum mine if results from exploration warranted it. The mine would be located along the West Fork of the Stillwater River. A haul road would connect the mine with the Picket Pin ranch which would be the site of a concentrator, settling ponds and possibly a smelter.

The mine would be above deer winter range and would probably have minimal effect. The haul road, however, would cross prime, east facing slope, mule deer range. The Picket Pin ranch was heavily used by wintering mule deer populations. The alfalfa hay meadows, proposed site for settling ponds, attracted large herds of deer in the spring. Considerable winter and spring range would be replaced by roads, buildings and settling ponds if the mine were developed. Losses due to an increasing human population would also be significant.

The proposed mines would primarily affect mule deer by physically removing winter range. Secondary effects such as air pollution and changes in life styles and economics of the valley may prove to be more detrimental to the deer in the long run. Unfortunately most of the adverse impacts will be unavoidable. Although the mule deer will probably survive large scale mining, the carrying capacity of these ranges may be considerably reduced.

Summary

Mule deer populations in the Beartooth mountains fluctuated greatly over the last 100 years. The relative estimates declined from "abundant" in 1880 to "scarce" by 1920. They increased through the 1930's and 1940's and probably peaked in the 1950's. The population has declined since.

Harvest data did not generally reflect population trends. Success declined sharply during the last two (1974 and 1975) hunting seasons.

Although overbrowsing by mule deer in the Stillwater area was noted as early as 1936, the first browse transects were not established until 1955. All transects recorded a reduction of juniper from 1955 through 1966. Results from cattle and deer enclosure plots indicated mule deer were responsible for the reduction.

Historical winter age classifications indicated production and/or survival was rarely above "fair." The fawn/100 adults ratios continuously declined since 1972-73.

Mule deer in the Stillwater valley wintered on most snow free areas below 7000 feet elevation. East and south facing slopes were heavily used.

Results from marked mule deer recorded complex movements between summer and winter ranges and between winter ranges.

Food habits studies indicated horizontal juniper was the main food item on the Picket Pin winter range. On Horseman Flats, horizontal juniper and arrowleaf balsamroot were the main items taken. Skunkbush sumac made up the bulk of the diet on the Stillwater winter range. In general, the deer were taking the available browse species.

Changing land use practices probably influenced deer populations in the past and will continue to do so in the future. Long term changes and combinations of factors makes determination of cause and effect relationships extremely difficult.

MOOSE

History

Moose were apparently absent or extremely scarce in the Beartooth Mountains at the turn of the century. Cooney (1937) maintained the first moose were seen in the Stillwater Canyon in 1919. One early resident (D. Whited pers. comm.), however, recalled seeing a bull moose in the Stillwater Canyon in 1912. He claimed cows appeared shortly thereafter. It was generally felt these early animals emigrated from Yellowstone National Park.

The 1925-30 Custer National Forest game report (McLean 1930) described moose as holding their own. The Beartooth Division moose population was estimated at 30 in 1925, 20 in 1926, 10 in 1927, 20 in 1928 and 20 in 1929. Extensive game counts were conducted on the Beartooth Division during the winter of 1935-36 (Cooney 1936). The only moose found were 15 along the Main Stillwater River. They ranged from Sioux Charley Lake to just south of Horseshoe Creek. Cooney (1936) stated, "the moose herd has remained very nearly at the same number for several years...it appears that the increase drifts out of the canyon and into Yellowstone Park by way of Slough Creek, via Lake Abundance."

The 1936-37 winter game counts (Cooney 1937) again found the entire

moose population, 20 head, restricted to the Stillwater Canyon. They were scattered between Sioux Charley Lake and Placer Park, some seven miles above the Big Park Ranger Station. The increase, reportedly, drifted out of the canyon in the fall by way of Horseshoe Creek, Lake Abundance and Daisy Pass and wintered in Slough Creek and along the northern boundary of the Park.

The estimated moose population of the Stillwater District increased from 75 in 1944 to 125 in 1946 (Mont. Dept. Fish and Game files). Increases were also noted for surrounding areas about this time (Schladweiler 1974).

The number of moose estimated to be residing in the main Boulder Canyon increased from 30 in 1935-36 to 90 in 1948. The 1949 survey noted moose sign and a few moose were seen in all major drainages along the upper Boulder River (Mont. Dept. Fish and Game files).

The main Stillwater Canyon moose population was censused in June 1950 (Thompson and Gaab 1950). Three bulls, two cows and two calves were observed from Woodbine trailhead to Big Park and one bull and two cows were counted from Big Park to Horeshoe Creek. They estimated 30 moose were residing in the Stillwater Canyon south of Woodbine. In addition, the West Fork of the Stillwater Canyon contained approximately 6 head. One bull was also seen along Picket Pin Creek.

The Stillwater Canyon was again surveyed in 1952 and Gaab (1952c) reported, "as many individual moose were accounted for by riding up the river to Big Park as were accounted for throughout the entire area on a complete survey three years ago." Lentfer (1954) mentioned more moose were seen in the Stillwater drainage in 1952 than in 1953 and 1954. By 1957 the population was considered to be in excess of the carrying capacity of the winter range (Forsman 1957).

The first aerial surveys of the Stillwater region were attempted in 1965 when 4 moose were counted along the Main Stillwater and 18 were seen between the Stillwater River and West Rosebud Creek (Foss and Whitney 1968). The following year 5 moose were observed in the Stillwater Canyon and 17 between the Stillwater River and West Rosebud Creek. In 1967 the number sighted in the Stillwater Canyon increased to 11 and 15 were counted in the Fishtail-Fiddler Creeks area (Foss, Gordon and Cada 1969). In the spring of 1970, 19 adults and 2 calves were observed in the Fishtail-Fiddler Creeks area (Gordon 1971).

The value of these aerial counts for population estimates was open to question. The area was carpeted by extensive stands of Lodgepole Pine and subalpine forests. Schladweiler (1974) noted moose spent considerable time in the coniferous habitat types during all seasons. Aerial observations of animals under these dense canopies was extremely difficult.

No attempt was made to total count the moose populations during this study. All observations were listed in Stoneberg (1974) and Table 40.

Table 40. Location, sex and age of moose sighted in the Beartooth Mountains from July 1974 to July 1976.1/

Date	Male	Female	Ad	Calves	Area	Location
8-15-74	1		1		Baboon Mtn.	S.14, R12E, T7S
9-23-74	1		1		Fishtail Creek	S.34, R16E, T5S
11-15-74	1		1		Stillwater River	S.6, R15E, T6S
6-30-75		1	1	1	Wounded Man Creek	S.9, R14E, T7S
10-19-75	1		1		Meadows	S. 26, R14E, T6S
11-21-75		1	1	1	Flood Creek	S.23, R14E, T6S
3-15-76			1		Hogan Creek	S.9, R19E, T7S
3-15-76			1		Fishtail Creek	S.11, R16E, T6S
3-31-76			1		Big Park	S.16, R14E, T7S

1/ Aerial and ground observations combined.

Moose or moose sign were sighted along the main Stillwater Canyon from Woodbine trailhead to the Stillwater Basin. Animals or sign were also observed along most of the side drainages. Flood, Wounded Man and Horseshoe Creeks were especially important.

Only one cow was observed in the West Fork of the Stillwater Canyon. Johns-Manville employees, however, occasionally encountered moose along the Iron Creek drainage. Local residents reported moose once occupied the pothole region at the mouth of the West Fork Canyon. None were observed there during this study. Prior to 1971 moose were occasionally sighted along the Picket Pin drainage. They were not sighted in this drainage nor along Castle Creek (except for one bull sighted at the confluence of Castle and Lodgepole Creeks in the fall of 1974), from 1971 to 1976.

The Benbow segment of the Stillwater Complex supported a small moose population. Moose or sign were located in Nye Basin (along Nye Creek), along Little Rocky Creek and around Chrome Lake. Late winter aerial flights suggested they moved out of this area and wintered at lower elevations along Little Rocky and West Fishtail Creeks.

The very limited data suggested moose numbers have declined and their range has decreased since the 1950's.

Range Conditions

The 1935-36 winter game survey (Cooney 1936) considered the Stillwater moose population to be well below the carrying capacity of the range. Food habits data listed willow as favored followed by aspen,

mountain maple, dogwood and chokecherry. Serviceberry and conifer needles were also taken (Cooney 1936).

In 1950, Thompson and Gaab (1950) found the principal browse to be wild currant. Other species listed to importance included, willow, Mountain maple, alder, and snowbush. They also recorded damage reports from ranchers in the lower Stillwater valley.

By 1957 moose numbers were considered in excess of the carrying capacity of the winter areas. In addition, excessive summer browsing was noted (Forsman 1957). Ellig (1959) surveyed the Stillwater and West Fork moose ranges in 1958.

Between Woodbine and Big Park the chokecherry and willow were in form class 3 and decadent or dead. Practically all fir production had been killed between Big Park and Wounded Man and mature firs were high lined. In addition utilization of aspen bark was noted. Along the West Fork, from the trailhead to Breakneck Park, chokecherry and willow were decadent or dead and aspen bark had been eaten.

In 1959 an exclosure was constructed in Breakneck Park along the West Fork of the Stillwater River. Transects were established to measure the impacts of moose on their food supply (Ellig 1961). Since the late 1960's, however, the transects have monitored elk use in this area.

The five year summary, 1960-1964, (Foss and Whitney 1965 and Table 41) indicated total browse intercepted inside the exclosure more than doubled while it remained unchanged outside. Willow and currant both increased considerably, birch remained stable and shrubby cinquefoil declined within the exclosure.

The 1970 two browse transects were established in the Stillwater Canyon (Gordon 1971). Mountain maple, chokecherry and dogwood were the species examined (Table 42). Dogwood received very heavy use during the three years the transects were read. Mountain maple was in the best condition and chokecherry was intermediate in use and condition.

General observations of the browse meadows along the Stillwater River indicated the willow and aspen were over mature and above the reach of moose. Dogwood and chokecherry were severely hedged. Alder dominated most meadows and was not used to any extent by the moose. Schladweiler (1974), studying the food habits of various Montana moose herds, also recorded very little use of alder.

Forest Service files indicated extensive forest fires spread through the Beartooth Mountains in the late 1800's. Dense stands of lodgepole pine were testimony to the extent of these fires. There have been no major fires in this area in the last 70 to 80 years. The moose population, invading in the early 1900's expanding both range and numbers in the 1930's, 40's and 50's then declining in the 1960's and 70's, may have been responding to habitat changes due to after fire vegetative succession. Controlled burning, therefore, should be considered as a management tool to improve the moose ranges of the Stillwater valley.

Table 41. Breakneck Park moose exclosure, browse intercept transect summary 1960-1964 (from Foss and Whitney 1965).

Species	Year	Inside Exclosure Transect 1	Inside Exclosure Transect 2	Inside Exclosure Total	Outside Exclosure Transect 3	Outside Exclosure Transect 4	Outside Exclosure Total
Ribes spp.							
	1960	-	4.0[2/]	4.0	2.0	5.2	7.2
	1961	-	5.6	5.6	1.4	2.8	4.2
	1962	ND[1/]	8.1	-	6.2	7.3	13.5
	1963	ND	11.9	-	5.5	7.7	13.2
	1964	0.8	15.6	16.4	3.8	5.5	9.3
Salix spp.							
	1960	8.9	6.9	15.8	7.7	2.3	10.0
	1961	14.1	17.7	31.8	4.0	8.4	12.4
	1962	ND	19.1	-	7.8	10.2	18.0
	1963	ND	22.6	-	5.0	11.9	16.9
	1964	32.7	26.9	59.6	2.0	10.0	12.0
Potentilla fruiticosa							
	1960	12.0	0.6	12.6	11.1	1.1	12.2
	1961	10.2	1.0	11.2	10.7	3.1	13.8
	1962	ND	1.0	-	9.8	3.5	13.3
	1963	ND	1.2	-	10.7	3.9	14.6
	1964	8.6	0.2	8.8	8.1	4.4	12.5
Betula spp.							
	1960	2.6	3.3	5.9	2.6	0.2	2.8
	1961	2.3	3.8	6.1	1.8	0.1	1.9
	1962	ND	3.1	-	0.9	1.2	2.1
	1963	ND	2.9	-	-	0.5	0.5
	1964	1.8	3.6	5.4	-	-	-
Total:	1960	23.5	14.8	38.3	23.4	8.8	32.2
	1961	26.6	28.1	54.7	17.9	14.4	32.3
	1962	ND	31.3	-	24.7	22.2	46.9
	1963	ND	38.6	-	21.2	24.0	45.2
	1964	43.9	46.3	90.2	13.9	19.9	33.8

1/ ND - No. Data

2/ Measurements in feet and tenths of feet.

Table 42. Summary of browse condition transects in the Stillwater Canyon 1970-1972 (from Gordon and Coop 1972 & 1973).

Plot No.	Year	Species[1/]	Form Class % 3 & 6	Age Class %Mat.	Age Class %Dec.	% Crown Area Dead	Leader Use %
1	1970	Ac gl	20	36	64	29	27
	1971	Ac gl	20	76	24	14	32
	1972	Ac gl	-	64	36	19	39
	1970	Pr Vi	48	36	64	32	24
	1971	Pr Vi	12	96	4	4	29
	1972	Pr Vi	56	80	20	9	49
2	1970	Cost	48	36	64	29	87
	1971	Cost	48	80	20	12	88
	1972	Cost	68	84	16	10	69

1/ Ac gl - *Acer glabrum* (Mountain maple)
Pr Vi - *Prunus virginiana* (Chokecherry)
Cost - *Cornus stolonifera* (Dogwood)

Hunting Season

The Stillwater Canyon was first opened to moose hunting in 1950 when three bull permits were issued. No seasons were apparently held in 1951, 52 or 56. In 1953 the number of permits was increased to 5 bulls and in 1957 they were changed to either sex. The number of either sex permits increased to 10 in 1958, 20 in 1959 and 25 in 1962.

In 1967 the Stillwater hunting district was split into two smaller units. Hunting district 512 included the Main Stillwater and West Fork drainages and hunting district 513 extended from Little Rocky Creek to West Rosebud Creek (Fig. 13). Ten permits were issued for H.D. 512 and 15 for H.D. 513. In 1974 the number issued for H.D. 512 was increased to 15.

Harvest data from hunter questionnaire returns for the 17 year period, 1958 to 1974, were presented in Table 43. The average yearly harvest was 10 moose. Hunter success ranged from 24 percent of those hunting in 1969 to a high of 80 percent in 1958. The overall sex ratio of the kill was 1.6 males to 1 female.

The data suggested that increasing the number of permits past 20 had little long term effect on the total harvest. Dividing the area into two smaller units resulted in a decreased total harvest. The

Table 43. Cumulative moose harvest data, from hunter questionnaire returns, for the Stillwater region 1958-1974.1/

Year	Permits Issued	Percent2/ Success	No. of Females	No. of Males	Sex Unkn	Total Adults	Total Calves	Age Unkn	Total Kill
1958	10	80	2	6	0	8	0	0	8
1959	20	50	2	7	0	8	1	0	9
1960	20	60	5	7	0	12	0	0	12
1961	20	58	2	9	0	10	1	0	11
1962	25	68	7	6	2	11	2	2	15
1963	25	65	8	6	1	10	4	1	15
1964	25	48	5	5	1	10	1	0	11
1965	25	39	5	4	0	9	0	0	9
1966	25	48	5	5	2	10	2	0	12
1967	25	30	3	4	0	5	2	0	7
1968	25	28	3	4	0	7	0	0	7
1969	25	24	1	5	0	4	2	0	6
1970	25	29	0	6	0	6	0	0	6
1971	25	42	1	9	0	10	0	0	10
1972	25	50	5	6	0	11	0	0	11
1973	30	54	6	8	0	14	0	0	14
1974	30	33	3	6	0	9	0	0	9

1/ Hunting District 513 was divided into two smaller units in 1967. After 1966 data from the two smaller units were combined.

2/ Percent success of permit holders that hunted.

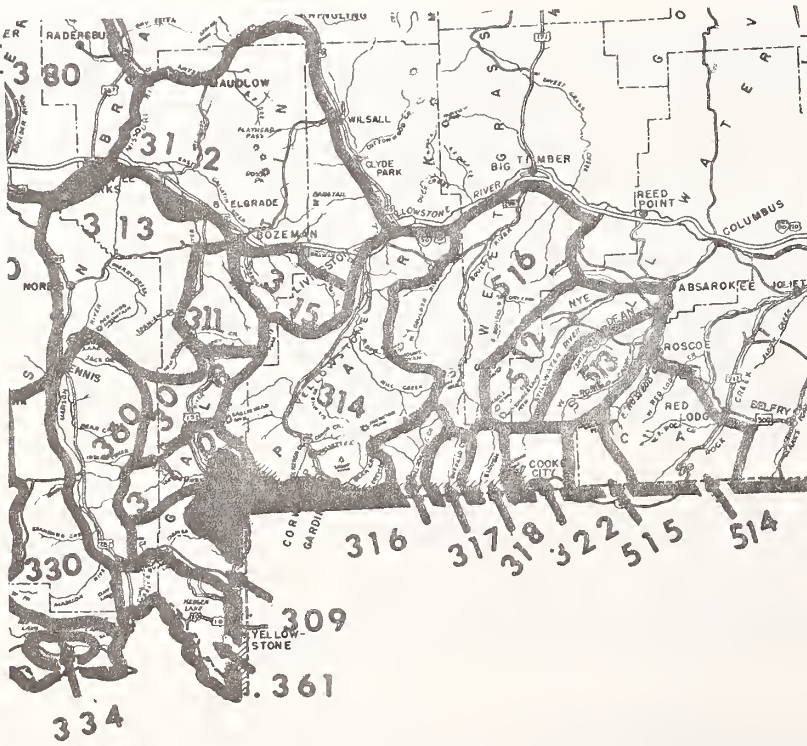


Figure 13. Location of moose hunting districts 512 and 513.

average yearly kill for the five years prior to 1967 was 12.4 moose and for the five years after 1966 was 7.2 moose. The difference was due to a reduced cow harvest after 1966. From 1962 to 1966 the sex ratio averaged .9 males to 1 female. The ratio changed to 3.5 males/female from 1967 through 1971.

The average yearly harvest from the Stillwater Canyon since 1967 was 3.4 moose (Table 44). The sex ratio of the total harvest (1967-1974) was 1.8 males to 1 female.

Table 44. Cumulative moose harvest data, from hunter questionnaire returns, for Hunting District 512 (Stillwater) 1967-1974.

Year	Permits Issued	Percent[1/] Success	No. of Females	No. of Males	Total Adults	Total Calves	Total Kill
1967	10	45	2	2	3	1	4
1968	10	20	1	1	2	0	2
1969	10	40	1	3	3	1	4
1970	10	25	0	2	2	0	2
1971	10	22	0	2	2	0	2
1972	10	38	2	2	4	0	3
1973	15	50	3	3	6	0	6
1974	15	31	1	3	4	0	4

1/ Percent success of permit holders that hunted.

The low success percentages suggested 10 permits would be optimum to obtain an adequate harvest of the Stillwater moose population.

Mining vs. Moose

Impacts of previous mining ventures on the Stillwater moose population were unknown. Schladweiler (1974) mentioned road construction, associated with logging, removed moose habitat and disturbed the animals. Mine roads which may have disturbed moose were the West Fork of the Stillwater road from Horseman Flats to the Johns-Manville adit, and the Picket Pin road from the forest boundary to Picket Pin Mountain. In addition Johns-Manville's two summer camps, Brass Monkey and Hoochville, were located in the Iron Creek drainage and were connected by a network of roads. This activity probably disturbed any moose summering in this area.

Mining activities in the Benbow area should be closely monitored to minimize disturbance to moose populations. Areas of present or

potential conflict included Little Rocky Creek, Nye Basin and Chrome Lake. Unfortunately, any mineral development in the Benbow area would be detrimental to the small resident moose population.

ROCKY MOUNTAIN GOATS

History

Mountain goats were not native to the Beartooth and Absaroka Mountana ranges (Foss and Rognrud 1971). The Montana Department of Fish and Game began transplanting goats to this area in 1942 (Table 45). Although the records were inconsistent, approximately 60 goats were planted. The four release sites were Rock Creek (South of Red Lodge), East Rosebud Creed, Stillwater River, and Pine Creek (Park County) (Fig. 14).

Table 45. Records of mountain goats transplanted to the Beartooth and Absaroka Mountains.

Year	Number	Release site
1942	12	Rock Creek (Red Lodge)
1945	2	Stillwater Canyon
1946	7	Stillwater Canyon
1948	5	East Rosebud Canyon
1952	10	East Rosebud Canyon
1953	7	East Rosebud Canyon
1956	5	East Rosebud Canyon
1957	10	Pine Creek (Park County)
1958	6	Pine Creek (Park County)
Total:	64	

Note - Small discrepancies existed between sources as to numbers and dates. The figures presented are approximate.

In 1942, 12 goats were planted in the Rock Creek drainage south of Red Lodge. The plant was checked in 1947 and a population of 10 goats was estimated (Rognrud 1947). It was noted that reproduction was occurring. By 1955, they were reportedly established near Line Creek and across the border into Wyoming (Gaab 1955). This population has never been extensively censused.

Goats were released at the mouth of the East Rosebud Canyon between 1948 and 1956. The exact dates and number of goats planted varied according to the source. However, this area received the largest number of goats over the longest period of time. These plants were first censused in 1971 when 58 goats were counted during an aerial flight from Froze to Death Plateau to Silver Run Plateau (Gordon and Coop 1973).

The two goats released along the main Stillwater River in the spring of 1945 were observed in the fall of the same year on the Boulder-Stillwater divide (Couey 1946). In 1952, two bear hunters encountered a goat along the upper West Boulder drainage (Gaab 1952). The animal was in such a weakened condition they were able to read the ear tag number (No. 9 Sun River herd). Gaab (1952a) reported, "The animal was transplanted in the Stillwater drainage near the Beartooth Ranch in the spring of 1942 as mature." The time of the plant, however, was probably 1945.

In 1955, five goats sighted on Roundhead Mountain (Buffalo Forks drainage) were assumed to have come from a Stillwater plant (Gaab 1955). In 1966, 48 goats were counted in the Absaroka Mountains.

The area west of the Boulder river was censused in 1972 and 61 goats were counted during one flight (Constan 1974a). In 1974, 67 goats were counted during one flight over the same area (Constan 1975). Also in 1974, an extensive aerial survey of the east side of the upper Boulder River indicated a minimum population of 10 goats (Coop and Simmons 1975).

In 1957 and 1958, 16 goats were planted in Park county along Pine Creek. A small population has apparently established at the head of this creek. In 1974, Constan (1975) counted 15 goats during one flight.

Present Distribution

The present distribution of mountain goats in the Absaroka and Beartooth Mountains reflected emigration from release sites. In general, the area supported four major populations (Figure 14).

Pine Creek

Constan (1975) showed the summer range of this herd extended from the South Fork of Davis Creek south to the South Fork of Pine Creek (T4S, R10E). This appeared to be a fairly small distinct herd.

Mill Creek-Hellroaring Creek-Boulder River Divide

This population apparently originated from the Stillwater plants. It may also have been supplemented by the later Pine Creek plants.

The goats ranged along the divide between Mill Creek and Hellroaring Creek from Thompson Lake in the southeast to Crow Mountain on the northwest. They extended north from Crow Mountain to the Pyramid along the divide separating Mill Creek and the Boulder River. To the south and east of Crow Mountain they ranged along the divide between Hellroaring Creek and the Boulder River to Sheepherder Mountain (Constan 1975).

From Sheepherder Mountain a few goats occupied the east side of the Boulder River north to Baboon Mountain. A few goats also occurred south of Sheepherder Mountain on Roundhead Butte.

Counts in 1974 indicated at least 77 goats occupied this range.

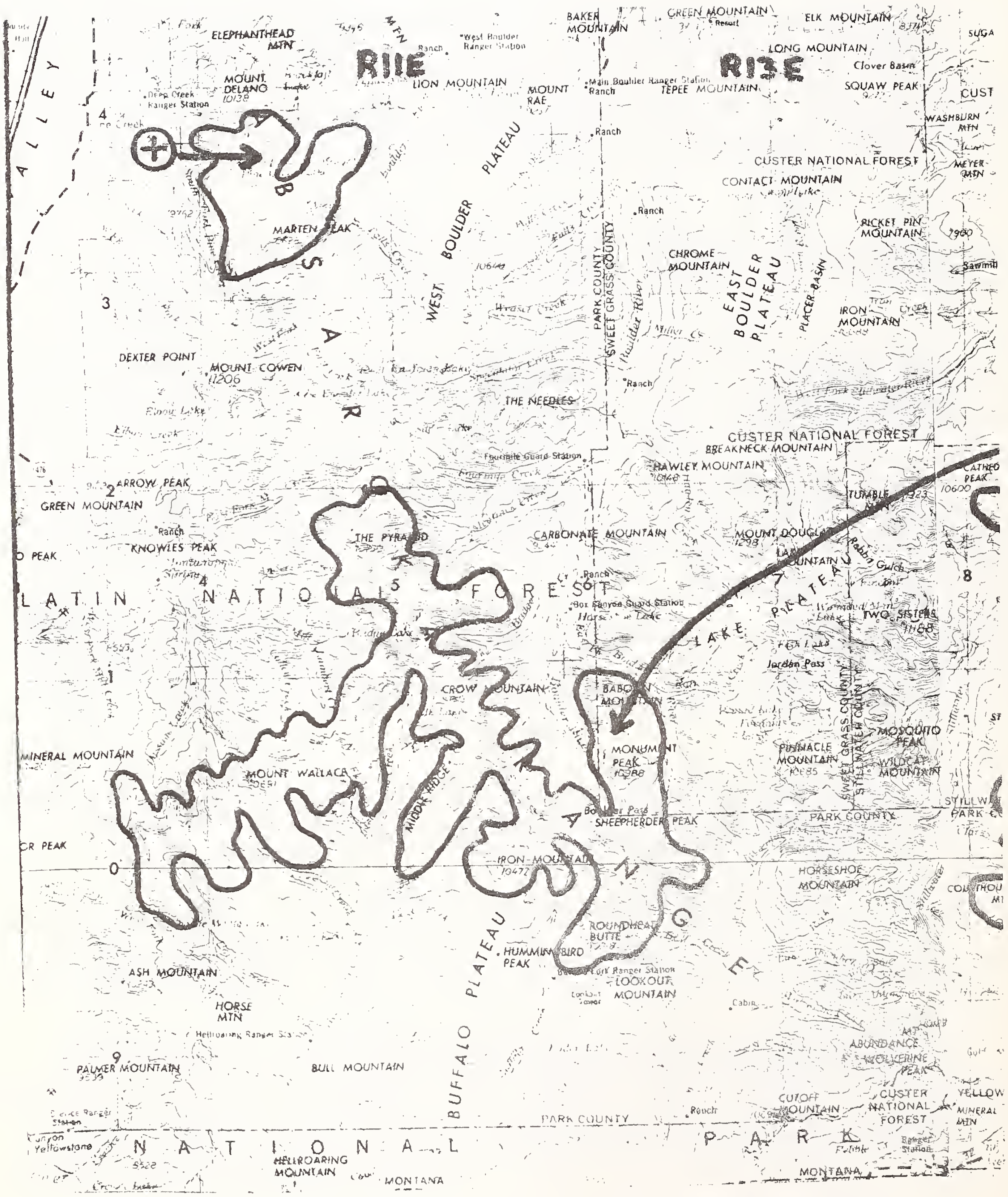
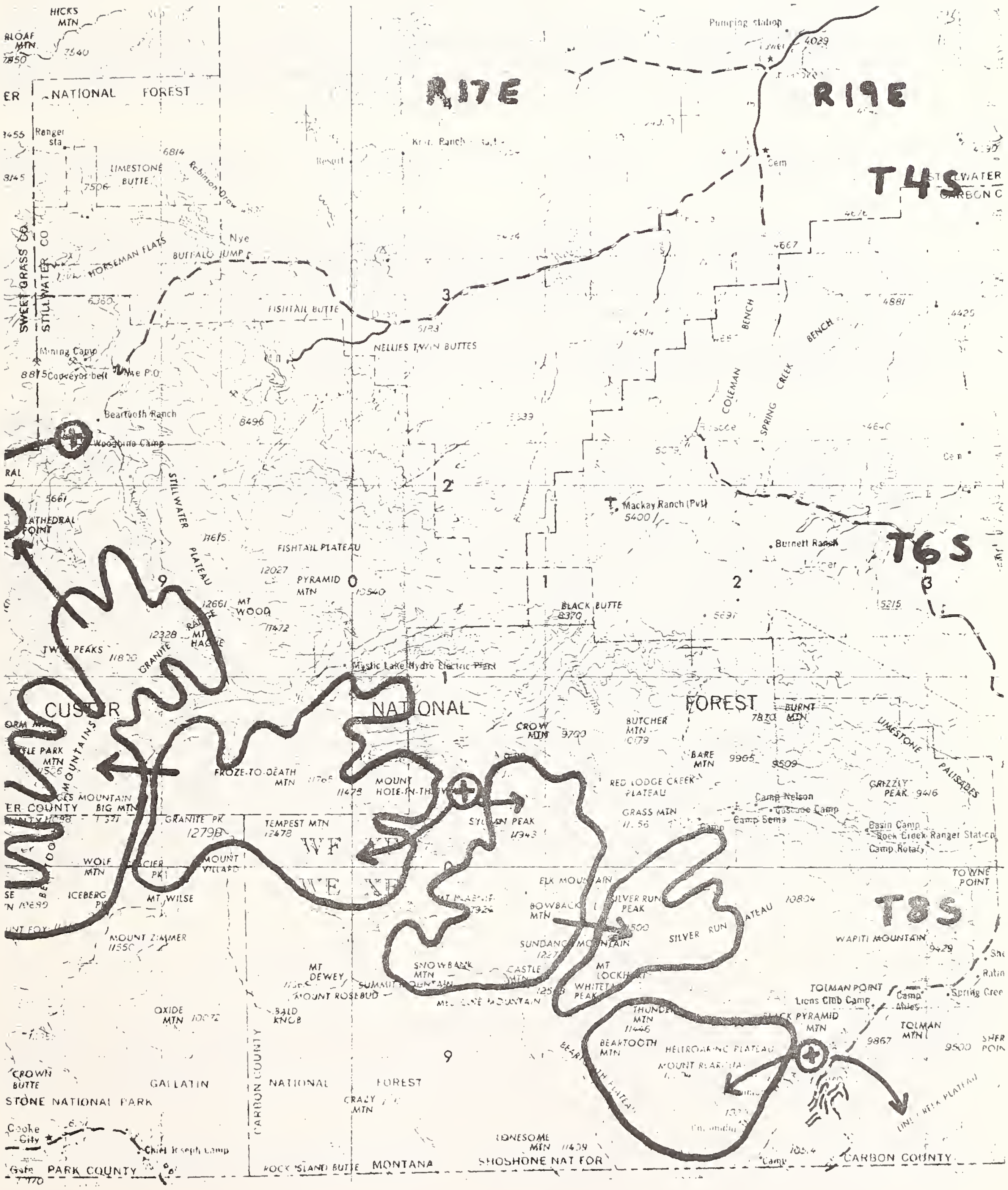


Figure 14. Distribution of mountain goats in the Absaroka and



Beartooth Mountains showing release sites ( ) and direction of dispersal.

Beartooth Mountains

The majority of goats in the Beartooth Mountains probably originated from the East Rosebud plants. They moved south and west from the release site to populate the plateaus between the East and West Rosebud Creeks. This area supported one of the largest goat populations in these mountain ranges. Maximum one flight counts decreased from a high of 77 goats in 1972 to 34 in 1975 (Table 50). It increased to 52 goats in 1976.

Although goats were observed on most plateaus, major concentration areas were Froze to Death Mountain, the plateau between Phantom Creek and Arch Creek, and the plateau south of Arch Creek.

Few goats were sighted south of Granite Creek and none were observed in the Clarks Fork drainage.

West of West Rosebud Creek the main goat concentrations were around Little Park Mountain, Big Mountain and Hodges Mountain. Scattered observations were also made from the plateau between Woodbine and Falls Creeks south to Courthouse Mountain. No goats were sighted on the Stillwater or Fishtail plateaus. Maximum one flight counts over this area increased to 28 goats in 1976 (Table 50).

One goat was observed on Cathedral Point on the west side of the Stillwater river and another was reported on Picket Pin Mountain (P. Stewart pers. comm.) west of the West Fork of the Stillwater River.

East of the release site goats occupied the East Rosebud plateau from Sylvan Lake south to Whirlpool Creek. They were mainly concentrated around Sylvan peak. However, observations of large herds in the Mount Inabit-Bowback Mountain area in 1974 indicated this may also be important goat range. The highest one flight count, 56 goats, occurred in 1974. Since then 15 and 12 goats were the high counts. No goats were observed south of the Clarks Fork Divide.

The goats inhabiting the Silver Run plateau also probably originated from the East Rosebud plants. This was supported by the fact most goats were observed on the northwest section of the plateau. Although individuals and small groups were regularly observed, large herds were only rarely encountered in this area. The highest one flight count was 30 goats in 1976.

Hell Roaring-Line Creek Plateaus

This population probably originated from the Rock Creek plants. They may, however, have been supplemented by a southeastward movement of the East Rosebud stock. They ranged south of the Lake Fork of Rock Creek and Rock Creek on Hell Roaring and Line Creek plateaus and, apparently, south into Wyoming. Little was known about the range of this population aside from the Hell Roaring plateau segment.

Individuals and small groups were occasionally observed over most of Hell Roaring plateau. The majority of the sightings were on the plateaus bordering Black Canyon Lake. The highest single flight count was 17 goats in 1974.

The present distribution of mountain goats was primarily obtained from aerial observations. The rugged terrain and difficult flying conditions limited sightings to those goats using the plateau tops. Therefore, more intensive aerial or ground surveys of the peripheral areas may extend the ranges of these populations.

The absence of marked animals prevented an assessment of the movements of goats from one area to another. It was noted a large group (20 to 30 animals) would be observed in an area during one flight and never resighted on subsequent flights. Whether they moved to a completely new area or left the plateau for the adjacent valley walls was unknown.

Future Distribution

Many regions of the Beartooth mountains had few if any goats. These areas had either not yet been invaded by the goats or were inhospitable to them. Assuming they were still radiating from their release sites, future movements could be predicted.

The population on Silver Run plateau may increase spreading east and south. However, counts during the last four years did not indicate this was occurring.

The plateaus between the Stillwater River and West Rosebud Creek appeared to contain suitable goat habitat. This was supported by the general similarity with the goat ranges to the east and by the fact a few goats now occurred there. This population will probably increase, spreading north to Fishtail plateau and south to Courthouse Mountain. Aerial censuses from 1972 to 1976 indicated this population was increasing.

The area between the Stillwater River and the Boulder River supported very few goats. The west side of the Stillwater River, from Sioux Charley Lake to Horseshoe Creek, appeared to contain suitable goat range. Areas between the Stillwater River and the West Fork of the Stillwater River also appeared suitable. Potential goat range was also located on the west side of the West Fork of the Stillwater River from Trail Creek to Lake Plateau. Lake Plateau and the areas to the south experienced heavy snow packs and probably lacked winter range. The region west of Lake Plateau may support mountain goats.

The main limiting factor to the range expansion of these goat herds was probably the availability of suitable winter range. However, no data were available on the winter requirements of these herds. Brandborg (1955) found goats in Idaho and Western Montana migrated to lower elevations in the winter and early spring. In the Bitterroot area of Montana he observed goats wintering on the south facing slopes of steep glacially carved U valleys.

The Beartooth mountains were characterized by high (9,000 to 11,000 feet) plateaus separated by deep, steep walled, U shaped valleys, flowing in a north-easterly direction. The present summer distribution of goats suggested they were selecting plateaus adjacent to these steep U valleys and the smaller hanging valleys which cut into the plateaus.

The southern slopes of the Beartooth Mountains lacked these deep glacially carved valleys. For this reason, goats will probably never be abundant south of the Clarks Fork divide.

Goats were observed wintering on wind swept ridges above 9,000 feet elevation. These ridges, however, were not available in the spring when deep snow carpeted the area. At these times goats probably used lower elevation ranges or very steep rock faces for foraging.

The main movement of mountain goats in the future will probably be west towards the Boulder River.

Hunting Seasons

The first mountain goat hunting season in the Beartooth Mountains was held in 1960 (Table 46). Ten permits were issued for the area from West Rosebud Creek east to the Clarks Fork River (hunting district 514, Fig. 15). The number of permits were gradually increased and by 1974, 80 were issued. The total kill increased as the number of permits were increased. Success varied from 36 percent to 81 percent (excluding 1960 when success was 0). Success may have been greatly influenced by weather conditions during the hunting season.

Table 46. Number of permits, hunter success and sex ratio of the kill from mountain goat Hunting District 514 (Rock Creek) 1960-1975.

Year	Permits Issued	Number Hunted	% Success	Male	Female	Sex Unkn	Total Kill
1960	10	6	0	0	0	0	0
1961	10	7	43	0	3	0	3
1962	10	9	67	4	1	1	6
1963	20	20	55	7	3	1	11
1964	20	16	75	7	4	1	12
1965	20	11	36	2	1	1	4
1966	20	16	50	5	3	0	8
1967	20	19	81	7	8	0	15
1968	25	24	55	8	5	0	13
1969	25	23	57	8	5	0	13
1970	24	22	59	10	2	1	13
1971	35	28	64	8	9	1	18
1972	35	30	77	14	9	0	23
1973	50	40	70	12	16	0	28
1974	80	74	59	25	19	0	44
1975	80	76	46	22	13	0	35

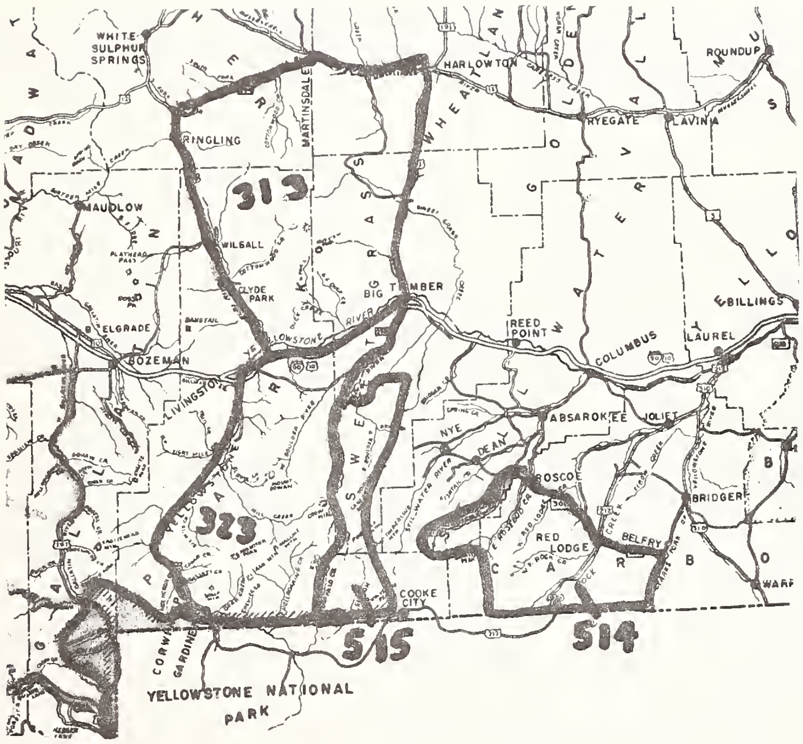


Figure 15. Location of Rocky Mountain goat hunting districts 514, 515 and 323.

The greatest harvest, 44 goats, occurred during the 1974 season. Of 211 goats known to have been harvested from H.D. 514 since 1960, 117 were known males and 88 were known females (1.33 males: 1 female).

The goat population in the Boulder River-Hellroaring Creek area overlapped the boundary between two game management regions (3 and 5). This resulted in the creation of two hunting districts (H.D. 323 and H.D. 515) in 1964 to harvest this population (Fig. 15).

Hunting district 515 included the portion of the range east of the Boulder River while hunting district 323 encompassed the area between the Boulder River and the Yellowstone River.

In 1964, 10 permits were issued in 515 and seven goats were harvested (Table 47). The harvest declined after this and success was 0 by 1971. In 1974 this area was closed to goat hunting.

Table 47. Number of permits, hunter success and sex ratio of the kill from mountain goat hunting district 515 (Boulder-Stillwater) 1964-1974.

Year	Permits Issued	Number Hunted	% Success	Male	Female	Sex Unkn	Total Kill
1964	10	8	88	7	0	0	7
1965	10	8	13	1	0	0	1
1966	15	13	25	3	0	0	3
1967	15	14	7	0	0	1	1
1968	5	3	33	0	1	0	1
1969	5	5	20	1	0	0	1
1970	5	5	20	1	0	0	1
1971	5	3	0	0	0	0	0
1972	4	1	0	0	0	0	0
1973	5	5	0	0	0	0	0
1974	Closed						

Fifteen goats were known to have been harvested in this district from 1964 to 1970; 13 males, 1 female, 1 sex unknown.

Ten permits were also issued in 1964 in H.D. 323 and six goats were taken (Table 48). The number of permits increased to a high of 60 in 1970 then declined to 30 in 1975. Success varied from 67 percent in 1964 to 30 percent in 1972. The number of goats harvested peaked at 24 in 1970.

Table 48. Number of permits, hunter success and sex ratio of the kill from mountain goat hunting district 323 (Yellowstone-Boulder) 1964-1975.

Year	Permits Issued	Number Hunted	% Success	Male	Female	Sex Unkn	Total Kill
1964	10	9	67	-	-	6	6
1965	10	9	44	-	-	4	4
1966	10	9	44	-	-	4	4
1967	20	14	64	-	-	9	9
1968	No data						
1969	50	43	51	-	-	22	22
1970	60	53	45	10	14	0	24
1971	60	52	40	12	9	0	21
1972	60	46	30	10	4	0	14
1973	40	31	42	7	6	0	13
1974	40	33	55	10	8	0	18
1975	30	25	60	10	5	0	15

The sex ratio of the known harvest from 1970 through 1975 was 59 males to 46 females (1.28 males: 1 female).

Hunters, returning questionnaire forms often mentioned success was hampered by inclement weather. The influence of this variable should have been roughly equal between H.D. 323 and H.D. 514. From 1964 through 1972 success decreased in H.D. 323 and increased in H.D. 514. The converse was true from 1972 through 1975. This difference may have been partially due to changes in the number of permits issued. Success relative to the number of permits available totaled 56 percent in the Beartooth Mountains for the four years, 1961-1972. The total for the next three years (1973-1975) was 51 percent. Comparable figures from the Absaroka Mountains (H.D. 323) were 35 percent and 42 percent.

Population Dynamics

Aerial flights to census the summer goat populations of the Beartooth Mountains began in 1971. Due to difficult flying conditions, only goats using the plateau tops were counted and classifications were limited to adult and kid categories.

Table 49 compared total classifications from 1971 to 1976. The data indicated overall production steadily declined from 53 kids/100 adults in 1971 to 17 kids/100 adults in 1976. Single flight classifications showed a corresponding decrease. However, the maximum number of goats observed during one flight remained relatively stable from 1973 through 1976 when coverage of the area was comparable.

Table 49. Counts and age classifications of mountain goats in the Beartooth Mountains derived from aerial censusing during July, August and September, 1971-1976.

Year	No. of Flights	Adults	Kids	Kids/100 Adults	Total
1971 1/	1	38(38) 2/	20(20)	53(53)	58(58)
1972	3	58(55)	28(27)	48(49)	86(82)
1973	4	224(71)	68(20)	30(28)	292(91)
1974	7	242(86)	57(19)	24(22)	299(105)
1975	4	155(77)	38(18)	25(23)	193(95)
1976	5	258(88)	44(16)	17(18)	302(104)

1/ From Gordon and Coop (1973).

2/ Total number observed during summer (highest count during one flight).

To further analyze the production decline the data were separated according to the major drainages (Table 50). In 1972, 51 kids/100 adults were observed between the two Rosebud Creeks. This ratio dropped to 27 in 1973. However, the two areas to the east, Rosebud and Silver Run Plateau, recorded 35 and 38 kids/100 adults, respectively, in 1973. By 1974 the decline had spread to the Rosebud Plateau, but a small sample size indicated production remained high on Silver Run Plateau. The kid/100 adults ratios in all three areas ranged from 24 to 27 in 1975. The ratio dropped sharply on Rosebud and Silver Run Plateaus and to a lesser degree between the two Rosebud Creeks in 1976.

Although the data were limited, kid/100 adults ratios from Hellroaring Plateau did not follow the same pattern as the ratios from the areas to the west. Production was very low in 1974 and 1975 and increased sharply in 1976.

The goat population west of West Rosebud Creek maintained fairly high production through 1975. An extensive survey of the area in 1976 indicated production had declined. However, the decline was less severe than on the areas immediately to the east.

The population west of the Boulder River originated from the Stillwater plants of 1945 and 1946. A sample of 48 goats classified in August of 1966 indicated a ratio of 60 kids/100 adults. Constan (1974a) censused this area in 1972, 26 years after planting. His July-September classifications (excluding the Pine Creek observations) totaled 30 kids/100 adults. A comparable census in 1974 recorded 34 kids/100 adults (Constan 1975).

Table 50. Summer (July-September) counts and age classifications of mountain goats between the major drainages of the Beartooth and Absaroka Mountains, 1972-1976.

Area	Year	Adults	Kids	Kids/100 Adults	Total
Rock Creek to Lake Fork of Rock Creek	1973	1(1)1/	0(0)	-	1(1)
	1974	21(14)	3(3)	14(21)	24(17)
	1975	21(13)	3(2)	14(15)	24(15)
	1976	12(9)	4(3)	33(33)	16(12)
Lake Fork of Rock Creek to West Fork of Rock Creek	1973	32(20)	12(7)	38(35)	44(27)
	1974	10(8)	4(3)	40(38)	14(12)
	1975	27(20)	7(5)	26(25)	34(25)
	1976	28(27)	3(3)	11(11)	31(30)
West Fork of Rock Creek to East Rosebud	1973	43(26)	15(9)	35(35)	58(35)
	1974	83(47)	17(9)	21(19)	100(56)
	1975	26(10)	7(5)	27(50)	33(15)
	1976	31(10)	3(2)	10(20)	34(12)
East Rosebud to West Rosebud	1972	51(51)	26(26)	51(51)	77(77)
	1973	144(52)	39(11)	27(21)	183(63)
	1974	152(35)	39(12)	26(34)	191(47)
	1975	70(28)	17(6)	24(21)	87(34)
	1976	143(44)	24(8)	17(18)	167(52)
West Rosebud to Stillwater River	1972	4(4)	1(1)	25(25)	5(5)
	1973	6(3)	2(2)	33(67)	8(5)
	1974 2/	23(13)	7(5)	30(38)	30(18)
	1975	11(11)	4(4)	36(36)	15(15)
	1976	44(22)	10(6)	23(27)	54(28)
Stillwater River to Boulder River	1973	-	-	-	-
	1974 2/	12(5)	4(2)	33(40)	16(7)
	1975	-	-	-	-
Boulder River to Yellowstone River (excluding Pine Creek)	1966 3/	30	18	60	48
	1972 4/	73(47)	22(14)	30(30)	95(61)
	1973 5/	21(16)	8(5)	38(31)	29(21)
	1974 6/	61(50)	21(17)	34(34)	82(67)

1/ Total number observed during summer (highest count during one flight).

2/ From Coop and Simmons (1975).

3/ Gaab (1966).

4/ From Constan (1974a).

5/ From Constan (1974b).

6/ From Constan (1975).

Fifteen goats were classified during one flight over the Pine Creek drainage in 1974 (Constan 1975), 16 years after the last plant. A ratio of 36 kids/100 adults was recorded.

Discussion

Production data indicated the Beartooth Mountains goat population followed the same pattern as the Crazy Mountains population (Lentfer 1955, Foss 1962); high production following introduction then declining production to a stable level of 25 kids/100 adults as the available ranges were filled and the herds matured. Additional support for this conclusion was provided by separating the summer age ratio data by major drainages (Table 50). The decline in production appeared to move eastward in successive years from the East Rosebud Creek release site. In addition, the area west of West Rosebud Creek contained a young, expanding goat population. The limited data through 1976 suggested production was slightly higher in this area than on the ranges to the east.

The Hell Roaring Plateau goat population probably originated from the Rock Creek plants of 1942. Extremely low age ratios were observed in 1974 and 1975. In 1976 a small sample size indicated production had increased. These data supported the assumption this population originated from a different source than other goat herds in the Beartooth Mountains.

Age ratio data from the Absaroka Mountains suggested production was high 20 years after planting and dropped markedly six years later. The timing of the decline was similar to what was observed in the Beartooth Mountains.

The influence of the hunting pressure on the production declines was debatable. In the Crazy's the decline followed a period of extremely heavy hunting pressure (Stoneberg and Foss 1976). However, Foss (1962) noted production was highest in areas subjected to the heaviest pressure. In both the Absarokas and the Beartooths production also declined following increased hunting pressure. In addition, extremely low production was observed on Hell Roaring Plateau in 1974 and 1975. An examination of hunter questionnaire returns indicated 30-40 percent of the harvest in the last five years had come from this readily accessible area. Production remained relatively high through 1975 on the plateaus between West Rosebud Creek and the Stillwater River. This area contained a young, expanding herd that had never been opened to hunting. The Absaroka goat population responded to a sharp drop in hunting pressure with a slight increase in production.

The data implied increased hunting pressure may decrease production. Sex ratios of the reported kills from both the Absaroka and Beartooth Mountains showed the female segment of the harvest increased as the number of permits increased. Excessive hunting pressure, therefore, could affect the population by increasing the removal of reproductively active animals.

Evidence against the influence of hunting pressure on production included, Silver Run and East Rosebud Plateaus both experienced production declines but hunter questionnaire returns indicated they supported very low hunting pressure. In addition, it was doubtful a change in the harvest of 10 to 15 goats over a 2 to 3 year period would cause the dramatic production changes observed.

The universal nature of the production decline in 1976 indicated it may have been due to extrinsic factors, such as weather. The data suggested the age ratios of these herds will stabilize at approximately 25 kids/100 adults.

Data from the Crazy Mountains indicated excessive hunting pressure resulted in a population reduction (Stoneberg and Foss 1975). The potential for similar reductions in the Beartooth and Absaroka mountains was expressed in the data. The readily accessible population at the head of the Boulder River (H.D. 515) was apparently reduced following several years of hunting. Single flight high counts from 1974 through 1976 declined on the heavily hunted Hell Roaring Plateau. In addition, the total harvest from H.D. 514 in 1974 was over twice as large as the kid crop observed during the previous summer. The fact that hunter success and total kill declined during years of high permit levels in both H.D. 514 and H.D. 323 suggested these populations were being over harvested.

In summary, the goats transplanted to the Beartooth and Absaroka Mountains produced at least four populations. They spread from the release sites and occupied most of the available range. The Beartooth population may continue expanding westward to the Boulder River.

The introduced herds exhibited high reproduction during the building and expansion period. Production dropped drastically 20 - 25 years after planting and will probably stabilize at approximately 25 kids/100 adults. Increased hunting pressure may have contributed to the decline. The evidence suggested excessive hunting pressure may reduce the total population.

WHITE - TAILED DEER

History

Cooney (1937) described white-tailed deer populations in the Beartooth Mountains as declining from "fairly abundant" in 1880 to "very scarce" by 1910. He claimed the last whitetail was seen in or near the Beartooth Range in 1925.

The Montana Dept. of Fish and Game transplanted whitetails to the Beartooth Mountains from 1945 through 1947. In 1945 and 1946, 22 and 21 head, respectively, were released along the Stillwater River in the vicinity of the Beartooth Ranch. Sixty-three head were planted along East Rosebud Creek in 1946 and 20 were released along the West Rosebud Creek in 1947.

Couey (1946), reporting on the success of the first Stillwater transplants, noted whitetails were occasionally seen around Sioux Charley Lake, along the West Fork, and on the main Stillwater River below Nye. He mentioned two bucks were killed during the 1945 hunting season; one near Nye and one on the West Fork near Limestone. By 1949 the Stillwater population was estimated at 100 deer. They were observed on Horseman Flats and along the Stillwater River above and below the Beartooth Ranch (Mont. Dept. of Fish and Game files). In 1950, Thompson and Gaab (1950) observed a white-tailed doe along the Stillwater River at Big Park.

Little information was collected on the Stillwater white-tailed deer populations during the 1950's and 1960's. Age composition counts were first recorded during the winter of 1971-72 (Gordon and Coop 1973). Forty-six adults and 38 fawns (83 fawns/100 adults) were observed in hunting district 52 (included Stillwater, West Rosebud and East Rosebud drainages). A smaller sample size, 12 adults and 11 fawns (92 fawns/100 adults), was obtained from hunting district 520 (previously H.D. 52) in 1973-74 (Gordon, Coop and Denton 1974).

Very few whitetails were classified during this study since they stayed mainly in the streamside deciduous vegetation on private land. The totals were 30 (76 fawns/100 adults) in 1974, 12 (71 fawns/100 adults) in 1975, and 22 (69 fawns/100 adults) in 1976. No conclusions can be drawn from the counts due to the small sample sizes.

Since shortly after the transplants, white-tailed deer hunting seasons were merely either-species provisions attached to the mule deer regulations. No special seasons were established specifically for white-tail management in the Stillwater region.

White-tailed deer contributed very little to the total deer harvest in hunting district 52 (520). Since 1962 the whitetail segment of the harvest varied from 2 to 11 percent.

Present Distribution

The Stillwater whitetails were generally associated with the stream-side deciduous vegetative zone. They were frequently observed feeding in the adjacent hay meadows.

The main whitetail range extended up the Stillwater River to about the mouth of Nye Creek (Fig. 16) and up the West Fork of the Stillwater River to about the middle of Horseman Flats. No whitetails were observed above Woodbine trailhead during this study. However, hikers occasionally reported seeing them in the Sioux Charley Lake and Big Park areas. They also occurred along the lower reaches of Little Rocky and Fishtail Creeks.

Land Use Impacts

The white-tailed deer habitat was primarily threatened by cattle

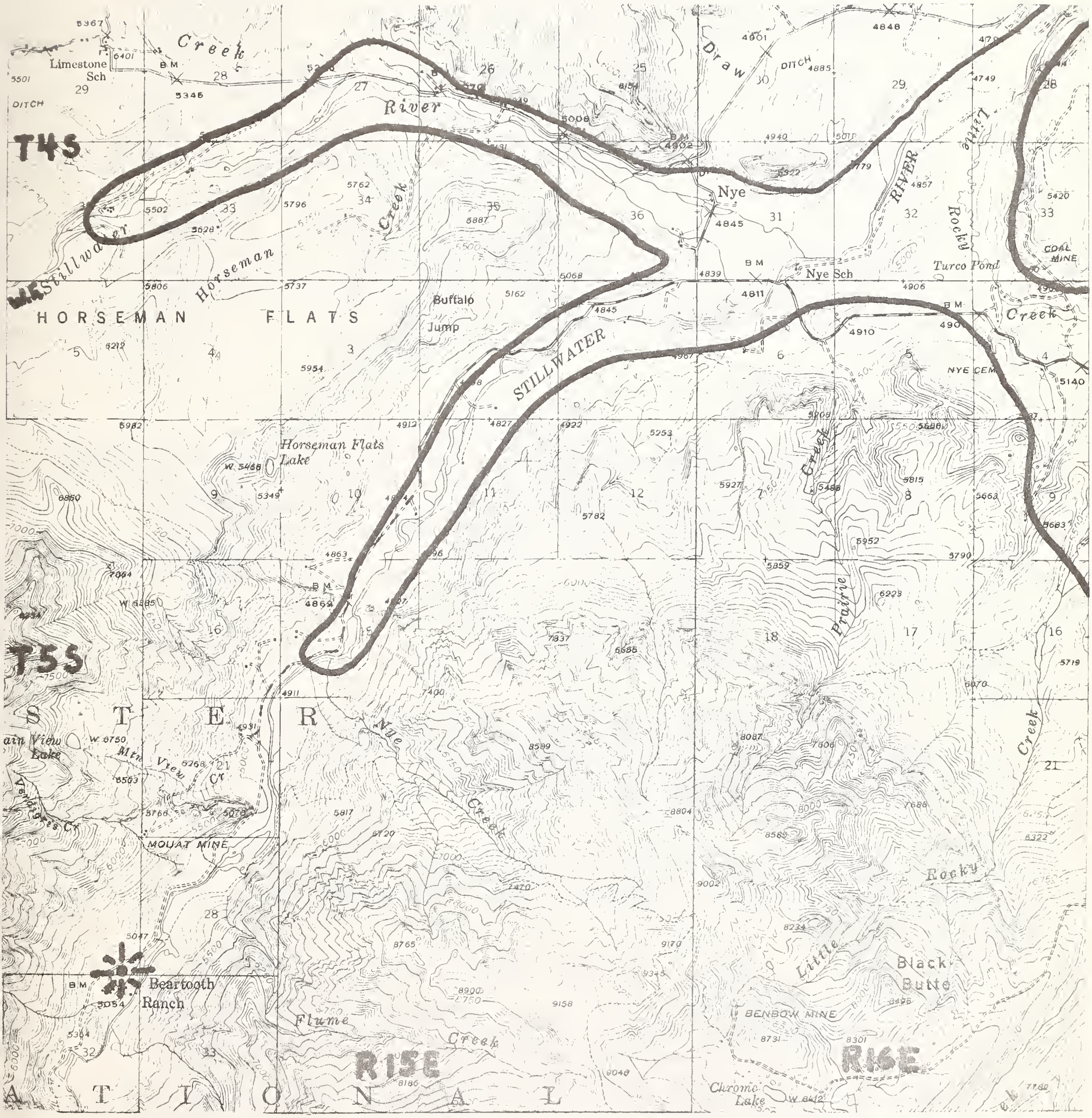


Figure 16. Approximate boundary of white-tailed deer distribution in the Stillwater region. The release site for transplanted deer is also shown (☀).

grazing and summer homes subdivisions. Cattle wintering in bottomland pastures generally bedded among the trees along the stream channels. The trampling and browsing frequently removed most of the understory vegetation. Little winter feeding was done along the Stillwater River above Nye.

The desire to locate summer cabins immediately adjacent to a stream channel will detrimentally impact the white-tailed deer. Generally, after road and cabin construction have removed critical habitat, landscaping and brush clearing greatly enlarged the total area impacted. The extent of the problem was directly related to the number and density of the cabins.

The on-going and proposed mining activities posed no immediate threat to the white-tailed deer populations. However, if the Johns-Manville operations proposed for the Picket Pin ranch were realized then upgrading the West Fork road to handle the increased traffic may destroy critical whitetail habitat.

BLACK BEAR

Sightings of black bear were made incidental to other work. All bear sightings were listed in Stoneberg (1974 and 1975). Bear observations ranged in elevation from 5000 feet along the Stillwater River to 9000 feet on the East Boulder Plateau. Sign and reported observations indicated black bear were numerous and widespread in the Stillwater region. Mining camps on Iron Mountain were occasionally plagued by prowling bears until an open pit dump was closed and all garbage was hauled off the mountain.

GRIZZLY BEAR

Reliable reports of grizzly bear sightings over the past 20 years indicated a few of these animals occasionally wandered into the Stillwater Complex region. None were seen during this study. The lack of data suggested the Stillwater mineralized zone did not contain a resident grizzly population.

GAME BIRDS

Blue Grouse

Distribution

Blue grouse were the most abundant and widely distributed game bird associated with the Stillwater Complex mineralized zone. They were found, at different times of the year, from the valley bottoms to the plateau tops at 10,000 feet elevation.

Most breeding males were observed in timber edge or road cut areas above 6000 feet elevation. Females with broods were generally observed in river bottom hay lands and on bunchgrass-forb and bunchgrass-sage slopes between 5000 and 6000 feet elevation. Broods were also observed on the plateaus and mountains above 9000 feet elevation. In the fall birds from the lower ranges migrated to the high elevation winter ranges.

Brood Counts

Blue grouse brood counts were conducted during July of 1972, 73 and 74 (Stoneberg 1975). These counts were discontinued due to the difficulty of obtaining an adequate sample size. Broods were distributed over a wide area and no concentrations were found. The limited data indicated average brood size declined from 4.9 chicks/brood in 1972 to 3.5 in 1974. The average brood size for all of region 5 showed a similar decline. From 1971 through 1974 the average number of chicks per brood was 5.1, 4.9, 4.8 and 4.2 respectively (Denton 1974 and Lorfing 1975).

Food Habits

Ten blue grouse crops were collected in September and October 1975 (Table 51). One was from the Mouat mine area and the other nine were from the subalpine forests of Picket Pin and Iron Mountains. The crop contents were identified but volumetric measurements were not obtained.

The one crop from the lower elevation Mouat area (collected Oct. 10) had the most diversified contents. Estimated volumes of the major food categories were: grasses--trace, forbs--35 percent, shrubs--25 percent, conifers--20 percent, and animal matter--20 percent.

The first four crops collected from the subalpine forest habitat type were entirely filled with berries of *Vaccinium scoparium*. A few leaves of this species were also present. A crop collected on September 28 was filled with *Antennaria* spp. leaves (50 percent) and *Vaccinium scoparium* berries (25 percent) and leaves (25 percent).

White bark pine seeds were the main item in four crops collected in early October. *Vaccinium scoparium* berries varied from 5 to 50 percent of the crop contents. Currant berries were present in two crops and conifer needles and insects occurred in trace amounts.

Schladweiler (1975) noted blue grouse diets shifted from forbs and shrubs to conifers as the birds moved from the low elevation breeding ranges to the higher winter ranges. He concluded, "Douglas-fir is probably the primary winter food of blue grouse in most Montana areas, although true firs (*Abies* spp.) might be locally important in some situations." Subalpine fir and whitebark pine needles were probably the most important winter food items in the Beartooth Mountains. This should be taken into account when logging of the subalpine forests is considered.

Mining vs. Blue Grouse

Activities associated with mineral exploration generally benefited blue grouse populations. Road cuts and drill site clearings provided display arenas for breeding males. Negative impacts would only occur following extensive habitat destruction. Nesting areas would be lost if the Picket Pin hay meadows were flooded. Strip mines and associated facilities on Iron and Picket Pin Mountains would reduce the amount of available winter range. However, the area disturbed would probably have to be quite extensive to noticeably affect blue grouse populations.

Ruffed Grouse

Ruffed grouse occupied the deciduous habitat types along the rivers and streams of the Beartooth Mountains. They were also encountered in the aspen patches along intermittent streams and around boggy areas on the mountain slopes.

No data were collected on this species during this study.

Other Species

Although Franklin's grouse were occasionally reported for the Beartooth Mountains, no authenticated sightings or collections were known. Cooney (1937) stated Franklin's grouse were not found on the Beartooth Division. Suitable habitat was censused with a trained dog during this study but no Franklin's grouse were found.

A small flock of Hungarian partridge were observed on Horseman Flats.

One male pheasant was observed along the West Fork near Nye and one or two others frequented ranch buildings along the main Stillwater above Nye.

Chrest (1971), mapping the distribution of white-tailed ptarmigan in Montana, showed the Beartooth Mountains as part of their range. However, no birds were seen nor authenticated sightings made during this study. It was doubtful white-tailed ptarmigan inhabited the Beartooth Mountains.

PREDATORS

Coyotes, bobcats, and mountain lions were the main predator species on or adjacent to the Stillwater Complex mineralized zone.

Coyotes, or sign, were observed in most habitat types from the valley bottom hay meadows to the alpine plateaus. They were observed harassing deer, elk and bighorn sheep on the winter ranges but no elk losses and few, if any, sheep losses could be attributed to coyote predation. No data were available to estimate the extent of the deer losses. The bone marrow of most winter killed mule deer indicated they were in poor nutritional condition.

Bobcats were rarely seen on or adjacent to the study area. They were occasionally trapped in the hills along the West Fork and main Stillwater Rivers but no data were available on their numbers or distribution.

Mountain lion observations were regularly reported from the Stillwater area during the winter months. No population data were available but the number of sightings appeared to increase in the last few years. This may have been due to decreased deer numbers forcing the cats to hunt the lower elevation winter ranges. If this trend continued mountain lion-livestock problems would probably occur.

RECOMMENDATIONS

Mule Deer

Techniques to monitor population changes in the mountain mule deer populations should be implemented.

Counts from either fixed-wing aircraft or helicopter should be made over specific areas at the same time and under the same conditions each year for comparable population estimates. These could be supplemented by ground counts of specific slopes or along a designated section of road.

Fawn/100 adults ratios should continue to be collected. Classifications should be listed according to specific areas to indicate changes occurring within a hunting district.

The winter range browse transect program should be reassessed. Transects should be established to measure utilization and abundance of all browse species on a particular range. This would be necessary to compensate for changes in the deer diets. From these data and nutritive value data the quality of forage on the various ranges could be determined.

Mule deer winter diets in different habitat types and during different climatic conditions should be periodically checked to supplement the transect data.

It would be desirable to determine the movements between summer and winter ranges of these deer herds. This could be accomplished through the use of radio transmitters.

The effects of land use changes, such as large scale mining, on the mule deer herds will be determined only through the use of sound monitoring techniques. The difficulty in collecting data on these mountain deer populations may be partially offset by concentrating on small, intensive study units.

White-tailed Deer

Distribution changes of white-tailed deer should be closely monitored. An attempt should be made to collect production data.

Whenever possible ranchers should be encouraged to fence creek bottoms to preserve whitetail habitat. The construction of summer homes on the flood plain should be strongly discouraged.

Moose

Information on moose numbers, reproductive rates, seasonal distribution and movements would be desirable. However, the large area, relatively small number of animals and dense vegetative cover would necessitate an enormous expenditure of time and effort to obtain a minimum of data. Schladweiler (1974) suggested late fall was the best time to census moose populations from an aircraft. Aerial counts in the Stillwater Canyon and adjacent drainages should be conducted each year immediately following the hunting season.

Fire should be used when practical as a management tool to improve the moose range in the Stillwater Canyon. This could be accomplished with prescribed burns or allowing wild fires to burn unchecked.

Hunter success figures for the past several years indicated 10 permits would be maximum for the Stillwater hunting district (H.D. 512).

Few moose apparently occured within the boundaries of the Stillwater Complex mineralized zone. Past mining operations and exploration activities may have caused the moose to avoid these areas. Therefore, future mineral developments should consider the impacts on potential as well as occupied moose habitat. Roads, camps, drill sites, etc. should not be located in creek bottoms and browse meadows. Revegetation of disturbed areas should include preferred moose browse such as willow, dogwood, chokecherry or aspen.

Elk

Periodic aerial counts of elk using the East Boulder Plateau summer range and the Horseman Flats-Picket Pin winter range should be continued. Efforts should be made to capture and radio tag elk wintering along the Boulder River.

The Stillwater Complex portion of the East Boulder Plateau has enormous potential for mineral development. Every effort should be made to restrict the mining activity and vehicle traffic to the area north of the road between Iron and Chrome Mountains. With any proposed development the requirements and well-being of the summering elk herd should be fully considered. Activities associated with mineral exploration and/or development should be discouraged between Breakneck Mountain and the road between Iron Chrome Mountains. The company should continue using a helicopter to service the block of claims around Breakneck Mountain.

Domestic sheep should not be allowed to graze south of the road between Iron and Chrome Mountains. The decision to reintroduce domestic sheep to the East Boulder Plateau should be delayed until the future plans of the mining companies are better known. Any land use management decisions should fully consider the requirements of the present and future elk herds.

Summer homes subdivisions on or adjacent to the Horseman Flats-Picket Pin winter range should be discouraged.

No off-road vehicle use (including oversnow vehicles) should be allowed on the Custer National Forest portion of the elk winter range. In addition, the jeep trail from the Picket Pin road to Swamp Creek should be legally closed and the closure enforced.

The Forest Service, Montana Department of Fish and Game and grazing permittees cooperatively should formulate management plans to reduce conflicts and to provide maximum benefits to both wildlife and livestock. In most instances the conflicts could be reduced or eliminated with better water distribution and drift fence construction.

The Picket Pin ranch and adjacent Forest Service lands should not be developed for mineral production. If the company proceeds with proposed developments, the elk herd wintering on and adjacent to the ranch should be used as an indicator of the environmental quality presently existing in the area that should not be degraded. The company and all regulating agencies should take appropriate steps to ensure that degradation is kept to a minimum.

Bighorn Sheep

Periodic censuses should be conducted throughout the winter to obtain total numbers, lambs/100 ewes, and the number and age of the ram segment. Radio transmitters should be placed on adult ewes to aid in locating lambing areas and summer ranges.

The hunting restrictions should remain the same as established for the 1975 season. The quota could be adjusted according to the census data. The winter range should remain closed to hunting.

Due to critical size of the winter range, no mining or development should be allowed on Forest Service land south of Mountain View Creek below 6500 feet elevation. No domestic livestock should be allowed on Forest Service lands west of Highway 419. Domestic sheep should not be allowed to graze the high plateau ram pastures at the head of the Boulder River.

Rocky Mountain Goats

At least two or three aerial flights should be made yearly in July and August to check numbers and production of the established goat herds. Effort should be made to search peripheral areas to determine the rate and extent of range expansion.

Studies should be initiated to determine the winter requirements of these goats. The quality and quantity of the winter ranges should be determined to estimate the carrying capacity of these mountain ranges.

Hunting seasons should be established to define the relationship between hunting pressure and production. The hunting districts should be split into smaller units to facilitate this and to provide more refined hunter harvest data. Permit numbers should be adjusted to prevent over-harvesting of these populations.

Table 51. Contents of ten blue grouse crops collected in September and October 1975 from the "Stillwater Complex" mineralized zone.

	Subalpine(9)1/	Douglas-fir(1)
GRAMINEAE (L)2/		1
Forbs:		
Antennaria spp. (L)	2	1
Trifolium spp. (L)		1
Unid. Forbs (L)	3	1
Shrubs:		
Arctostaphylos Uva-ursi (B)		1
Ribes spp. (B)	2	1
Rosa spp. (H)		1
Symphoricarpos albus (B)		1
Vaccinium scoparium (B,L)	9	
Trees:		
Abies lasiocarpa (N)	1	
Picea engelmannii (N)	1	
Pinus albicaulis (S)	4	
Pinus contorta (N)		1
Pseudotsuga menziesii (N)		1
Animal		
INSECTA	2	1

1/ ( ) number of crops from habitat type. Number of crops containing item.

2/ Plant parts: L - Leaves, B - berries, H - hips, N - needles, S - seeds.

Game Birds

Winter requirements of blue grouse should be studied prior to approving timber sales in the subalpine forest.

Consideration should be given to the feasibility of transplanting both Franklin's grouse and white-tailed ptarmigan to the Beartooth Mountains. The extensive stands of lodgepole pine would probably support sizable Franklin's grouse populations. The alpine plateaus of the Beartooths were similar to white-tailed ptarmigan habitat in northwestern Montana and Colorado. The inclusion of these two species to the fauna of the Beartooth Mountains would enhance the aesthetics and increase the recreational opportunities in the area.

General

The varied and abundant wildlife populations on and adjacent to the Stillwater Complex mineralized zone should be viewed as indicators of the level of environmental quality currently existing in the area. As mans' activities continue to chip away at the land base upon which these populations are dependent, losses will inevitably occur. Although individual projects may have little immediate impact, the long range and cumulative effects may be significant. Therefore, land managers of both the private and public sectors should seriously consider whether increased economic development outweighs the unavoidable environmental degredation.

Mining of the Stillwater Complex on national forest lands should not be allowed until stringent safeguards are developed to protect the existing wildlife populations.

Banding a ewe.

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APPENDIX

Scientific nomenclature of plants mentioned in the text.

Scientific Name	Common Name
TREES:	
Abies lasiocarpa	Alpine fir
Alnus spp.	Alder
Juniperus scopulorum	Rocky mountain juniper
Picea engelmannii	Engelmann spruce
Pinus albicaulis	White bark pine
Pinus contorta	Lodgepole pine
Pinus ponderosa	Ponderosa pine
Populus tremuloides	Quaking aspen
Populus trichocarpa	Black cottonwood
Pseudotsuga menziesii	Douglas-fir
SHRUBS:	
Acer glabrum	Mountain maple
Amelanchier spp.	Serviceberry
Arctostaphylos uva-ursi	Bearberry
Artemisia tridentata	Big sagebrush
Berberis repens	Oregon grape
Betula occidentalis	Water birch
Ceanothus velutinus	Snowbrush
Cornus stolonifera	Red osier dogwood
Juniperus communis	Common juniper
Juniperus horizontalis	Horizontal juniper
Ledum glandulosum	Labrador tea
Lepargyrea canadensis	Nannyberry (Buffaloberry)
Phyllodoce empetriformis	Purple heather
Phyllodoce glanduliflora	Yellow heather
Physocarpus malvaceus	Ninebark
Potentilla fruticosa	Shrubby cinquefoil
Prunus virginiana	Chokecherry
Rhus trilobata	Skunkbush sumac
Ribes aureum	Currant
Ribes spp.	Gooseberry
Rosa acicularis	Prickly rose
Rosa spp.	Rose
Rubus idaeus	Raspberry
Salix spp.	Willow
Shepherdia canadensis	Buffaloberry
Symphoricarpos albus	Snowberry
Vaccinium scoparium	Huckleberry
FORBS:	
Achillea millefolium	Yarrow
Agoseris glauca	Flase dandelion

FORBES (cont.)

Allium spp.	Onion
Anemone globosa	Anemone
Antennaria spp.	Pussytoes
Arenaria spp.	Sandwort
Arnica latifolia	Arnica
Arnica longifolia	Arnica
Artemisia frigida	Fringed sage
Artemisia ludoviciana	Cudweed sagewort
Aster spp.	Aster
Astragulus spp.	Vetch
Balsamorhiza sagittata	Arrowleaf balsamroot
Caltha rotundifolia	Marsh marigold
Campanula uniflora	Hairbell
Campion lychnis	Campion
Castilleja spp.	Paintbrush
Cerastium arvense	Chickweed
Chrsopsis villosa	Golden aster
Cirsium foliosum	Elk thistle
Dryas octopetala	Dryas
Epilobium spp.	Fireweed
Equisetum arvense	Horsetail
Erigeron peregrinus	Fleabane
Eriogonum spp.	Buckwheat
Fraseria spp.	Elk sedge
Galium spp	Bed straw
Gentiana spp.	Gentian
Geranium viscosissimum	Sticky geranium
Geum spp.	Avens
Geum triflorum	Old man's whiskers
Hedysarum sulphurescens	White sweet vetch
Hieracium gracile	Slender hawkweed
Linum lewisii	Flax
Lupinus spp.	Lupine
Melilotus officinalis	Yellow sweet clover
Mertensia spp.	Bluebell
Mimulus spp.	Monkey flower
Pedicularis groenlandica	Elephant head
Penstemon spp.	Beards-tongue
Phlox hoodii	Hood's phlox
Polygonum bistortoides	Bistort
Potentilla glandulosa	Cinquefoil
Potentilla spp.	Cinquefoil
Ranunculus spp.	Buttercup
Sedum integrifolium	Roseroot
Sedum stenopetalum	Stonecrop
Senecio subnudus	Groundsel
Senecio triangularis	Ragwort
Solidago spp.	Golden rod
Taraxacum officinale	Dandelion
Trifolium spp.	Clover
Zygadenus elegans	Camus

GRASS AND GRASS-LIKE PLANTS:

Agropyron intermedium	Intermediate wheatgrass
Agropyron smithii	Western wheatgrass
Agropyron spicatum	Bluebunch wheatgrass
Agropyron subsecundum	Bearded wheatgrass
Agropyron trachycaulum	Slender wheatgrass
Agrostis scabra	Ticklegrass
Bromus marginatus	Mountain brome
Bromus tectorum	Downy chess brome
Calamagrostis canadensis	Bluejoint
Carex spp.	Sedges
Danthonia intermedia	Timber oatgrass
Deschampsia caespitosa	Tufted hairgrass
Elymus spp.	Wild rye
Festuca idahoensis	Idaho fescue
Festuca ovina	Sheep fescue
Juncus balticus	Wire rush
Juncus spp.	Rushes
Koeleria cristata	Junegrass
Phleum alpinum	Alpine timothy
Phleum pratense	Timothy
Poa spp.	Bluegrasses
Stipa spp.	Needlegrasses
Trisetum spicatum	Spike trisetum

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BOOK TWO

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ABSTRACT

Chemical and biological investigations were undertaken in streams draining an area of southcentral Montana where mining development is expected. More intensive work was done in the West Fork Stillwater River drainage where development seems imminent.

Water quality was generally good. Waters, with some exceptions, are soft and low in dissolved materials. Dissolved and suspended metals were found only in low concentrations. Turbidity and suspended solids remained low except for the snowmelt period when values reached moderate levels. Stream temperature measurements with maximum-minimum thermometers showed a summer maximum temperature of 60 F for stations in the West Fork Stillwater River drainage.

Standing crops of streambottom macroinvertebrates were variable, both in time and location. At most stations organisms considered sensitive to pollution were dominant. Species identification data are shown for stations on two streams.

Fish population estimates were made for 27 sections in 16 streams. Standing crops were moderately low in larger streams, but moderately high in some brushy, meandering tributaries. Young-of-the-year fish were present in most stream sections. Population estimates were mostly similar from one year to the next. Fish tended to remain in the same stream section from one year to the next, and grew somewhat more slowly than state averages.

Survey electrofishing was done on stream sections where fish population estimates were not made. Fish populations were lacking, except near the mouth, in most small streams and in the upper reaches of almost all streams.

A limited investigation was made in the West Fork Stillwater River of trout redd physical characteristics, spawning dates and egg hatching dates.

Limited data on fish stomach contents suggest fish cropped a wide variety of aquatic organisms. Survival to hatching of trout eggs placed in artificial redds was variable, largely in response to water temperature.

Data are shown for metals concentrations in fish muscle tissue.

Requests for minimum streamflow reservations, under the state law, "Montana Water Use Act," were submitted for streams with significant fish populations.

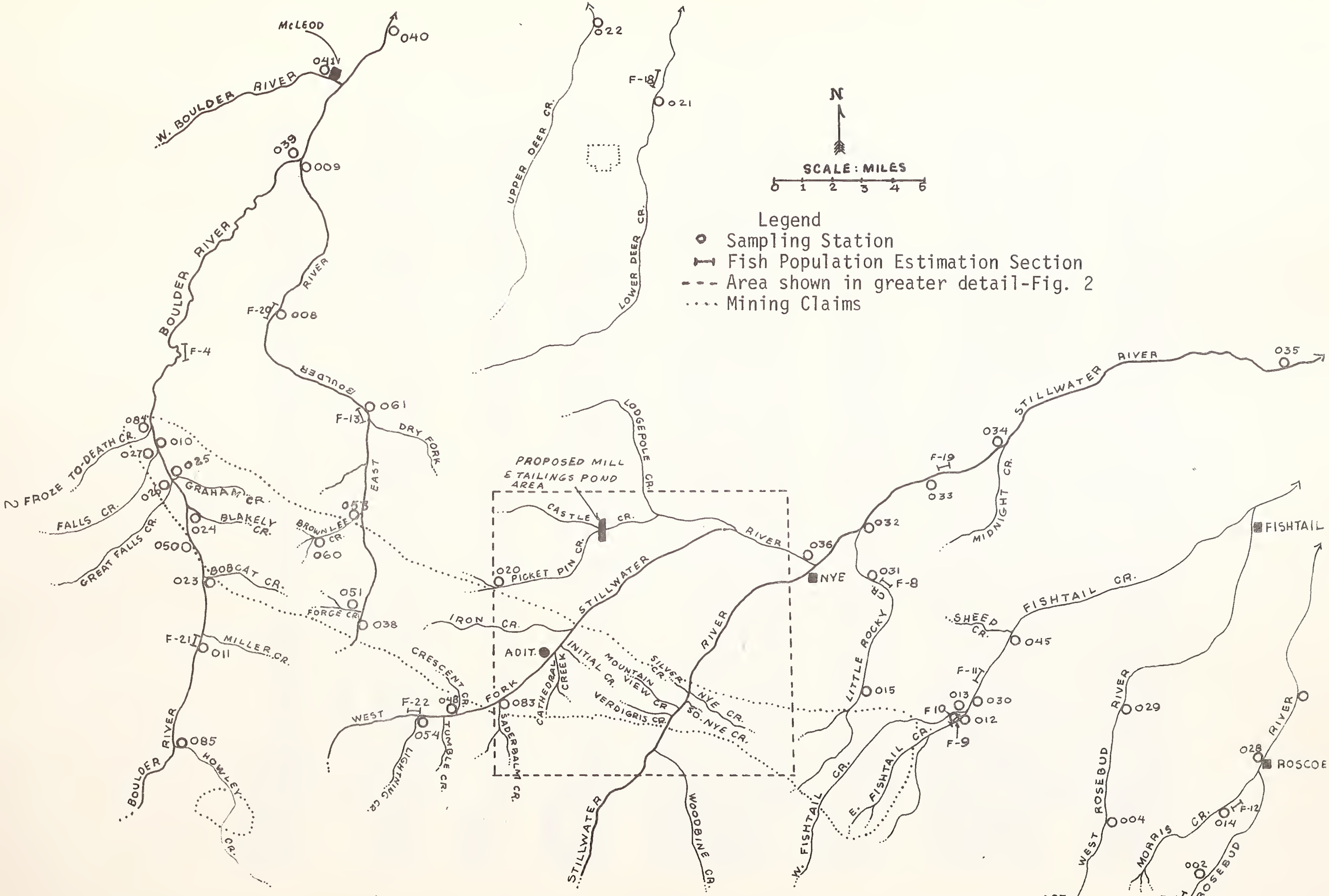

Figure 1. Study area streams showing location of sampling stations and fish population estimation sections.

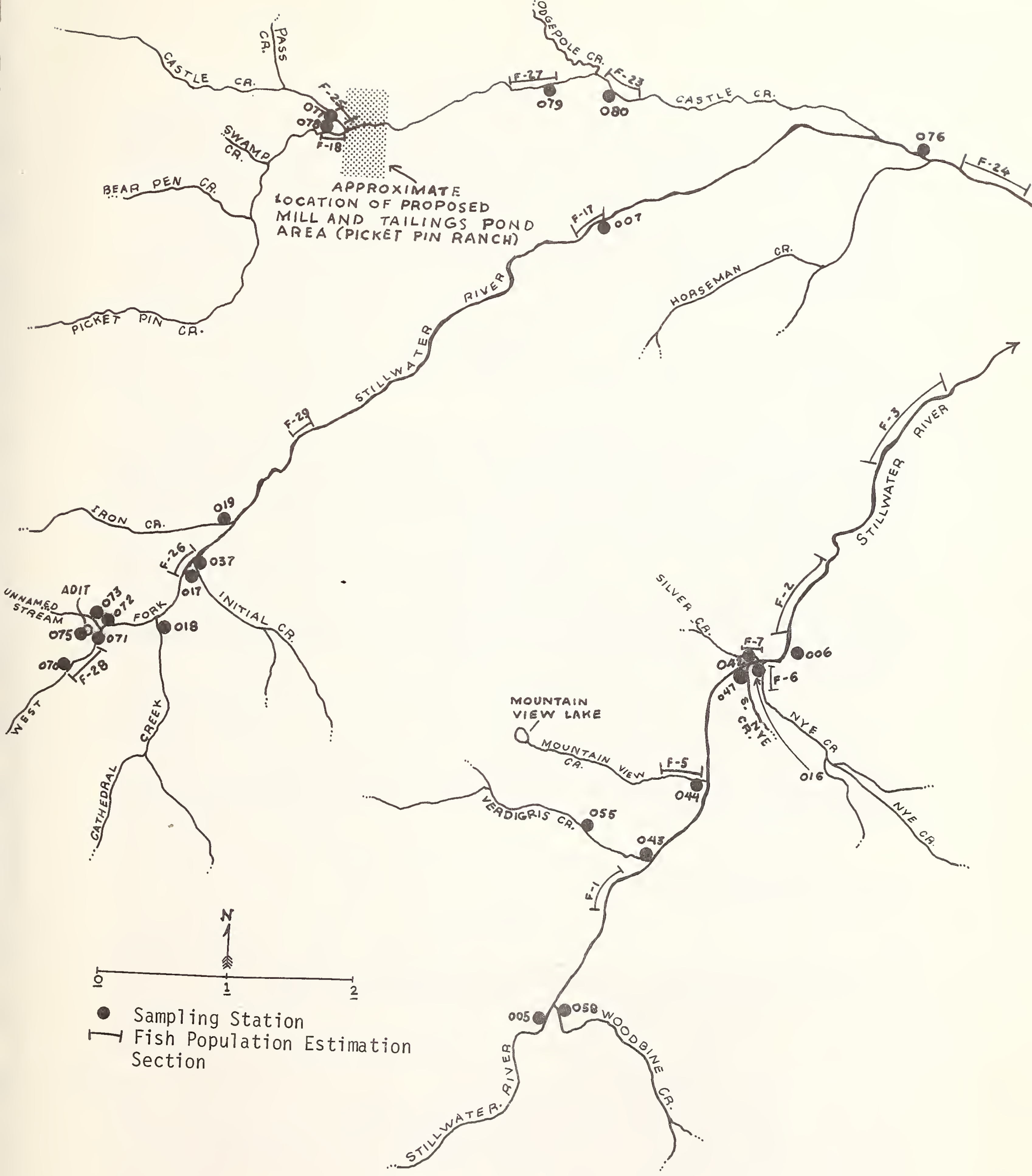

Figure 2. Enlarged portion of Figure 1 showing sampling stations and fish population estimation sections in a portion of the Stillwater River drainage.

BACKGROUND

Several thousand acres of hard-rock mining claims are located along or near the north edge of the Beartooth-Absaroka mountain range in south-central Montana (Figures 1 and 2). Most of the claims were established in the late 1960's, but some claims have been added in the period 1970-1976. Extensive mining in this area seems likely in the near future. Claims in the Deer Creeks area and in the Rosebud River drainage are of lesser concern because these claims have been dropped by the companies involved.

In late 1974 or early 1975 Johns-Manville Corporation purchased the Picket Pin Ranch (Figure 2) as a potential mill and tailings pond site and for other functions that would be related to any mine developed as a result of their exploration adit near the West Fork Stillwater River (Figure 2).

Work began on this exploration adit in December 1974 and continued until early 1976 when the adit operation was halted by the Montana Department of Health and Environmental Sciences because of an illegal discharge of groundwater released into the adit by drilling and blasting. This discharge was contaminated with ammonia and nitrate from blasting materials and entered the West Fork Stillwater River by an underground route. As of this writing, the adit operation is suspended until the Johns-Manville Corporation formulates a chemical and biological monitoring program for the adit drainage and obtains approval of this program by the DHES. Facilities to allow an emergency watertight seal of the adit will also be required.

The overall goal of protecting aquatic resources was undertaken initially by chemical and biological surveys at stations upstream and downstream from mining claims. This work was begun in 1970 and was largely completed by late 1974. Work in 1975 and 1976 consisted of developing more intensive physical, chemical and biological data related to the exploration adit and ranch purchased for future mill and tailings ponds.

Data files from this project are stored in the Billings Department of Fish and Game office.

OBJECTIVES

Job objectives were to obtain the following information at stations upstream and downstream from the complex of mining claims:

1. Basic water quality data
2. Metals concentrations in stream sediments
3. Numbers per square foot and species present in streambottom fauna samples
4. Fish population estimates and species distributions in streams
5. Metals concentrations in fish tissues
6. Information on organisms present in fish stomachs
7. Survival to hatching of hatchery trout eggs placed in artificial redds.

Additional objectives were to obtain the above plus the following information at stations related to the Johns-Manville adit and mill-tailings pond sites in the West Fork Stillwater River drainage:

1. Weekly maximum-minimum stream temperatures
2. Trout redd characteristics and early life history
3. Stream discharge data where lacking.

A final job objective consisted of determining minimum streamflows required to maintain fish and other aquatic life in study streams with significant fish populations and to request these flows under section 89-890 of the state law entitled "Montana Water Use Act."

PROCEDURES

Sampling Stations

Sampling stations were established at points upstream and downstream from the mining claims complex. Other stations were located upstream and downstream from the Johns-Manville adit and the Picket Pin Ranch. Station locations are shown in Figures 1 and 2. Appendix A is a listing of township, range, section and location description for sampling stations.

Water and Stream Sediment Quality Sampling

Values for temperature, turbidity, pH and dissolved oxygen were obtained in the field. Spot temperature measurements were made with a Taylor pocket thermometer. Maximum-minimum thermometers were made by the same company. Turbidity and pH were measured colorimetrically (Hach Chemical Company field unit model DR-EL). Dissolved oxygen was measured by the Winkler method.

Other parameters were analyzed at the Montana Bureau of Mines and Geology laboratory in Butte under contract agreement with the Montana Department of Fish and Game. Field procedures used were suggested by laboratory personnel.

Water samples were collected in plastic bottles after three rinsings with stream water. Bottles for nonmetals analysis were filled to capacity to prevent air contact. One percent (by volume) of concentrated nitric acid was added in the field to bottles of water for metals analysis. Prior to 1973 water for dissolved metals analysis was not filtered. For samples in 1973 and later, these samples were filtered. Filter pads of 0.45 micron pore size obtained from the Gelman Instrument Company were used for filtration.

Stream sediment samples for metals analysis were collected from the upper inch of sandy or silty deposits at each station. Sediments were transported to the laboratory in cloth bags. Prior to analysis in the laboratory, samples were screened through material of 100 meshes per inch (0.0059 inch opening size). Only materials passing through the screening were retained for analysis. The analyst for sediment samples was the same as for water samples.

Streambottom Macroinvertebrates

Bottom macroinvertebrates were sampled with a "Water's Round" square foot sampler slightly modified from that described by Waters and Knapp (1961). One riffle sample per station was collected in August or October 1970 and in April 1971. Three samples per station were collected at later sampling dates. Riffles were chosen for sampling as these locations are known to have the greatest abundance and diversity of macroinvertebrates.

Various nonriffle habitat types were also sampled once or twice at most stations. This was done with a Needham hand screen. These organisms have not been sorted and remain in storage.

Samples were preserved in the field in 10 percent formalin and were sorted to order (insects) or other taxonomic groups for noninsect organisms. The number, and in most cases, volume, of organisms were obtained for each taxonomic group in each sample. All organisms were preserved for possible future work.

Indentification to species (or lowest possible taxonomic group) was done by Mr. Robert L. Newell for samples from the West Fork Stillwater River. At that time Mr. Newell was employed by the Montana Department of Fish and Game. Mr. Dana Schmidt (Ecological Consulting Service, Inc., Helena, Montana) identified organisms from samples on the East Boulder River. Mr. Schmidt's work was verified by an outside expert for each insect order. Although very few changes were made by these experts, their changes are used in this report.

Fish Studies

Population estimates were made using methods similar to those described by Vincent (1971). A computer program was used to make the required calculations. The basic technique involves capturing fish by electrofishing in a stream section and marking them in a manner recognizable at a future date (fin clip was used in this study). Several days later fish were again captured in the stream section, noting whether or not each fish was marked. Fish in each stream section were given a distinctive mark each year. They were aged from scale impressions. Fish were weighed to the nearest 0.01 pound and total lengths were taken to the nearest 0.1 inch.

On the larger streams electrofishing gear was floated downstream while fish were captured. On smaller streams electrofishing was done while wading. A backpack shocker unit was used on remote stream sections.

The formula used by the computer program is:

$$N = \frac{(M+1)(C+1)}{R+1} - 1, \text{ where:}$$

N = population estimate
M = number of fish marked
C = number of fish in recapture sample
R = number of marked fish in recapture sample (C)

Scales were collected by 0.1 inch length intervals (three per 0.1 group if sufficient numbers of fish were captured). For purposes of the estimate, the population was usually divided into several length groups, with efficiency of fish capture similar within each group. Each group contained at least seven recaptured fish. The fish in each group were apportioned to the various age groups, according to the aging from scales.

In a few instances, when numbers of recaptured fish were low, only a single length group was used to estimate the population.

Fish stomachs and fish for metals analysis were collected during the last recapture run, or at a later date if convenient. Fish stomachs were preserved in 10 percent formalin and stomach contents were identified to order. Fish collected for metals analysis were frozen the day of collection and later shipped on dry ice by air freight to the Environmental Protection Agency in Denver, Colorado where the analysis was performed.

Trout redds were located by observing adult fish excavating redds or by excavating in gravels. Measurements on redds were made only while the redd was being excavated by adult fish or shortly after eggs were laid. Velocities over redds were measured with a Price Model AA or pygmy current meter.

Egg Bioassays

Eggs were buried in artificial redds to determine survival rates during the incubation period. Redds were built by excavating the streambottom in riffle areas to a depth of 12 to 14 inches, leaving a semispherical depression 2.5 feet in diameter. This was filled with clean gravel averaging 0.84 inches in diameter.1/ Redds were allowed to settle and stabilize at least 2 weeks before egg placement.

Procedures for the adit drainage egg bioassay and the control bioassay in the adjacent West Fork Stillwater River were somewhat different. A small plastic wading pool was placed below the adit drainage pipe to collect a pool of water. The wading pool was partially filled with 1-4 inch diameter gravel from the West Fork Stillwater River. The control redd was filled with similar gravel.

Eyed cutthroat trout eggs were obtained from the Montana Department of Fish and Game Yellowstone River Trout Hatchery at Big Timber for egg bioassays in 1972. For the years 1973 through 1975, eyed rainbow trout eggs were obtained from the Ennis National Fish Hatchery near Ennis. In 1976 eyed cutthroat trout eggs from the Montana Department of Fish and Game Jocko River Trout Hatchery near Arlee were used for bioassays.

On all occasions, eggs were placed in trays at the hatchery, covered with crushed ice, and placed in artificial redds the same day they were

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1/Diameters were measured on gravel used in 1973. Gravel used in other years was of similar size.

taken from the hatchery. One or two hundred eggs were returned to the Big Timber hatchery following egg placement in redds. This was done to measure the effect of transportation and handling, if any.

Two different types of egg containers, both constructed to retain fry after hatching, were used to contain eggs in redds. A few eggs were placed in small perforated vials which were removed periodically to determine when hatching had occurred. Three (two in 1976) containers made of plastic screening were filled with 100 eggs each and buried 4-6 inches deep in each redd. Gravel chips were placed in the screen containers in 1973-1976, but not in 1972.

The redd at station 007, 1973, was not stable. Most of the gravel washed away between the time the redd was constructed and the day of egg placement. As an emergency measure, the screen containers were placed on what little remained of the gravel from which the redd had been built and large (2-4 inch diameter) gravel was collected from the streambank and placed over the containers.

After hatching, the screen containers were removed and the fry were counted.

Fish Bioassays

Cutthroat trout fry (approximately 2 inches total length) from the Yellowstone River trout Hatchery were used for a bioassay of the adit drainage and for a control in the adjacent West Fork Stillwater River. Fish were transported from the hatchery in an aerated tank and placed in locked metal live cars. The control live car was submerged in a stream pool. The test live car was placed in a plastic wading pool under the adit drainage outfall.

Streamflow Measurements

Stream discharge measurements were made using methods described by Buchanan and Somers (1969). The Price Model AA or pygmy current meters were used depending on water depths. The 0.6 method was used for all measurements.

Minimum Streamflow Reservations

All sources of information from other agencies were utilized in developing minimum streamflow reservations (MSR's). These sources included U. S. Geological Survey (USGS) published streamflow records for the Stillwater River near Nye, near Absarokee and near Woodbine campground; for the Boulder River near Big Timber and near Contact; and miscellaneous measurements for Little Rocky Creek, Castle Creek and the West Fork Stillwater River. Miscellaneous streamflow measurements by other agencies were also utilized.

Data developed during this project and used in formulating MSR's included once per month stream gaging during low flow periods and twice per month gaging during the runoff period at seven stations in the West Fork

Stillwater River drainage; stream gaging at previously ungaged sites at times when flow was known to be near the annual minimum; fish population and life history information; photography of fish habitat at various streamflows; Bureau of Reclamation Water Surface Profile (WSP) computer program data.

The WSP program generates information on stream widths, depths and velocities at any desired discharge from cross sectional physical measurements made at a single flow. This program allows the investigator to gain knowledge of stream widths, depths and velocities at any flow, including flows lower than those that actually occur.

FINDINGS

General Chemical Water Quality

Location of sampling stations is shown in Figures 1 and 2. Appendix A contains station descriptions. Maximum and minimum values for the various chemical parameters and station where the value was recorded are in Table 1. Appendices B through K give more detailed results of chemical analyses.

Waters are of the calcium bicarbonate type (typical of fresh water), very soft to moderately hard, and generally low in dissolved material. A few streams have moderate levels of dissolved materials - these are: Silver Creek (spring source), Upper and Lower Deer Creeks, Castle Creek, Picket Pin Creek, the lower reaches of the East Boulder River, and the West Fork Stillwater River downstream from the confluence of Castle Creek. In general, human activities have probably modified water quality only slightly (with one exception to be discussed later).

Some chemical concentrations were strongly negatively correlated with discharge. Higher levels of the major ions (Ca, Mg, Na, HCO_3, SO_4) were found at low streamflows. This was also true of dissolved solids, alkalinity and hardness.

Dissolved oxygen values were always near saturation values. This would be expected in unpolluted, turbulent, shallow streams.

Values for the various metals were low and often below laboratory detection limits. Values for aluminum at some stations on Castle Creek (Appendix G) were somehwat higher (up to 5.02 mg/liter). This aluminum was largely in the suspended rather than dissolved fraction and these higher values were found only at elevated streamflows with concomitant elevated suspended loads.

Lower Verdigris Creek contained definitely elevated concentrations of some metals (Table 1 and Appendix D). At station 043, near the mouth, nickel and copper were as high as 0.59 and 0.14 mg/liter), respectively. However, at station 055, which is approximately 1 mile upstream, these metals were below detection limits for all samples (Appendix D). Between these two stations the stream passes through a gossan (area of decomposed rock of rusty color due to oxidized metal pyrites). One water sample was

Table 1. Maximum and minimum values recorded for various chemical parameters and station where recorded.[a, b,c]

		Maximum	Minimum
	Ca[d]	55.0 (East Boulder R.-009)	1.3 (Forge Cr.-051)
	Mg	20.7 (Castle Cr.-077)	0.0 (Great Falls Cr.-026)
	Na	12.7 (East Boulder R.-009)	0.5 (several stations)
	K	2.5 (East Boulder R.-009)	0.10(Brownlee Cr.-053 & 060)
	SiO_2	18.5 (South Nye Cr.-047)	0.0 (West Rosebud R.-003)
	HCO_3	208 (Castle Cr.-079, 080)	7.0 (Saderbalm Cr.-083)
	CO_3	5.0 (East Boulder R.-009)	0 (most stations)
	OH	0 (all stations)	0 (all stations)
	Cl	3.30(Verdigris Cr.-043 & E. Boulder R.-009)	0.0 (several stations)
	SO_4	74.0 (Silver Cr.-042)	0.20(Forge Cr.-051)
	NO_3-N	0.54(Verdigris Cr.-055)	0.00(several stations)
	F	0.8 (Castle Cr.-077)	0.00(most stations)
	pH(lab)	8.53(East Boulder R.-038)	5.80(West Fork Stillwater R.-037)
	pH(field)	8.7 (several stations)	6.7 (Saderbalm Cr.-083)
	Dis.sol.	392.2 (Castle Cr.-080)	16.1 (Saderbalm Cr.-083)
	Hard.	211 (Castle Cr.-077)	4.0 (Saderbalm Cr.-083)
	DO	16.0 (Stillwater R.-005)	5.0 (Iron Cr.-019)
	Alk.	204.0 (Castle Cr.-079)	6.0 (Saderbalm Cr.-083)
Dissolved	Zn	0.03(Crescent Cr.-048)	<0.01(several stations)
Dissolved	Cd	<0.01(all stations)	<0.01(all stations)
Dissolved	Cu	0.14(Verdigris Cr.-043)	<0.01(most stations)
Dissolved	Ni	0.59(Verdigris Cr.-043)	<0.02(most stations)
Dissolved	Fe	1.10(Morris Cr.-014)	0.00(most stations)
Dissolved	Mn	0.36(Morris Cr.-014)	0.00(most stations)
Dissolved	Al	0.19(W. Fk. Stillwater R.-037)	<0.05(most stations)
Total	Zn	0.02(Castle Cr.-080)	<0.01(most stations)
Total	Cd	<0.01(all stations)	<0.01(all stations)
Total	Cu	0.01(several stations)	<0.01(most stations)
Total	Ni	0.03(W. Fk. Stillwater R.-076, Picket Pin Cr.-078)	<0.02(most stations)
Total	Al	5.02(Castle Cr.-080)	<0.05(most stations)
	JTU	250 (South Nye Cr.-047)	0 (most stations)
	T. susp. sol.	192.16(Boulder R.-010)	0.10(several stations)
	V. susp. sol.	11.36(Boulder R.-010, Stillwater R.-005)	0.10(several stations)

Table 1 continued. Maximum and minimum values recorded for various chemical parameters and station where recorded.[a, b, c]

[a]Stream and station number shown in parentheses

[b]Units are milligrams per liter except as indicated

[c]Values for drainage from the Johns-Manville adit are not included

[d]Standard chemical abbreviations, and as follows:

- Dis. sol. = calculated dissolved solids
- Hard. = total hardness as $CaCO_3$
- Alk. = total alkalinity as $CaCO_3$
- DO = dissolved oxygen, field
- JTU = turbidity-field, Jackson Turbidity Units
- T. susp. sol. = total suspended solids
- V. susp. sol. = volatile suspended solids

taken from a spring that emerges from the base of the gossan and enters Verdigris Creek. In this sample, nickel and copper values were 0.68 and 0.31 mg/liter, respectively. The gossan and probably this spring contribute the greatly elevated amounts of metals found in lower Verdigris Creek. The realtive contribution of natural and human factors to this situation are difficult to assess. The gossan surface and the lower portion of the watershed has undergone considerable disturbance from road building. At any rate, water quality in Verdigris Creek is good upstream from the gossan.

Both Nye and South Nye creeks are filled with mill tailings which have blown in from the Mouat tailings pond located a few hundred yards up the Stillwater River valley. This has had no obvious effect on water chemistry in these two streams, but the natural streambottoms and banks have been almost completely destroyed in the lower 0.5-0.75 mile.

Table 1 and Appendices B through K indicate discrepancies between field and laboratory pH measurements of 1.0-2.0 units. Laboratory values were always lower. Laboratory measurements were made 1-2 months following sample collection, while field pH was measured within a few minutes after sample collection. To find out which set of pH values was correct, a simultaneous comparison of laboratory and field pH meters was made on water that had been collected the day before (Table 2). Samples were collected January 24, 1973 and measurements made on January 25, 1973. There was good agreement between the two meters when measurements were made at the same time and soon after sample collection. Values of pH were in the range 7.9-8.5, agreeing with previous field measurements. Apparently pH value decreased considerably between time of collection and time of laboratory measurements. The conclusion is that the field measurements rather than the laboratory measurements indicate true pH values in streams.

Table 2. Comparison of pH measurements made simultaneously with laboratory and field instruments.

Stream	Station	Field Instrument	Laboratory Instrument	Difference
West Rosebud	004	7.98	7.91	+0.07
Stillwater	006	8.12	8.13	-0.01
West Fork Stillwater	007	8.45	8.24	+0.21
East Boulder	009	8.53	8.46	+0.07
Boulder	010	8.05	8.11	-0.06

Only Saderbalm Creek consistently had pH values slightly on the acid side of neutral. At most other stations pH values tended to lower somewhat during spring runoff, but even these mostly remained on the alkaline side of neutral.

The U. S. Geological Survey has published considerable water quality data for one station on the Stillwater River and one on the Boulder River. The Custer National Forest has also collected considerable water quality data on streams draining the mining claims complex. The individual mining companies involved (Johns-Manville, Anaconda and Amax) have also measured water quality at stations in the area.

Appendix G shows values for nitrate in the discharge water from the Johns-Manville adit. This discharge entered the West Fork Stillwater River by an underground route. Elevated concentrations of nitrate were first detected in the West Fork Stillwater River on January 28, 1976 in analyses by the Montana Department of Health and Environmental Sciences (Table 3). The nitrate source was blasting materials used in the adit.

Nitrate in the West Fork Stillwater River was from 2-3 times greater downstream from the entrance of the adit water as compared to upstream locations. Elevated nitrate did not persist in the West Fork Stillwater River. Later analyses by the Montana Department of Health and Environmental Sciencesindicated a drop in nitrate concentrations in the adit discharge following cessation of blasting inside the adit and a concomitant decrease of nitrate in the West Fork Stillwater River downstream of the adit discharge entrance to values similar to upstream locations.

Table 3. Summary of nitrate (mg/l as N) in the West Fork Stillwater River upstream and downstream from the Johns-Manville adit.

Distance[a] upstream or downstream from adit	Date 1/12/76	1/28/76[b]	2/7/76[b]	2/8/76[b]
0.5 miles upstream	0.09	0.06	0.09	0.09
30 feet downstream			0.09	0.10
200 yards downstream			0.09	0.09
350 yards downstream			0.09	0.09
500 yards downstream			0.09	0.12
800 yards downstream			0.17	0.17
1 mile downstream	0.09	0.18	0.17	0.16

[a]distances are approximate

[b]analysis by Water Quality Bureau of the Montana Department of Health and Environmental Sciences

No effect of the adit discharge was found on streambottom fauna or fish populations.

High pH values in the adit discharge (Appendix G) were due to periods of grouting inside the adit to seal off some of the groundwater.

In June and July, short-term flow through bioassays were run with cutthroat trout eggs and fry to detect any toxicity of the water. None was found.

Fish bioassay live car in plastic wading pool below outfall of adit drainage. Light-colored rock in foreground is from adit located just out of picture near upper left. 7/2/76

Turbidity and Suspended Solids

Turbidity was measured routinely at the time of sampling for general water quality at all stations (Appendices B through K), and more intensively in 1974 at selected stations (Table 4). Suspended solids were sampled intensively at stations on larger streams in 1974 (Appendix L) and routinely at the time of collection of samples for general water quality analysis at stations in the West Fork Stillwater River drainage in 1975 and 1976 (Appendices E and G). Suspended solids were also measured at stations on two Boulder River tributaries in 1975 (Appendix K).

Both parameters varied with water flow rates. Even the higher values during runoff in May and June are moderate. High values for turbidity

Table 4. Mean turbidity[a] and number of samples (in parentheses) by months for various stations, 1974.

Station	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Larger streams										
Stillwater River										
005	3(2)	1(2)	6(4)	14(6)	1(2)	0(2)	0(3)	0(1)	0(2)	0(1)
006	3(2)	2(2)	6(4)	18(6)	1(2)	0(2)	0(2)	0(1)	0(1)	0(1)
032	3(2)	3(2)	6(4)	22(6)	0(2)	0(2)	0(2)	0(1)	0(1)	--
034	5(2)	5(2)	6(4)	29(6)	0(2)	0(2)	0(2)	0(1)	0(2)	0(1)
West Fork Stillwater River										
037	--	--	4(4)	13(6)	0(2)	0(2)	0(2)	2(1)	0(1)	2(1)
007	0(2)	1(2)	4(4)	15(6)	0(2)	0(2)	1(2)	0(1)	0(2)	0(1)
East Boulder River										
061	--	--	10(1)	12(6)	0(2)	0(2)	0(2)	0(1)	--	--
008	3(2)	3(2)	6(4)	13(6)	0(2)	0(2)	0(2)	0(1)	0(2)	0(1)
009	4(2)	9(2)	16(4)	41(6)	0(2)	2(2)	3(2)	0(1)	3(2)	--
Boulder River										
011	5(1)	3(2)	7(4)	17(6)	0(2)	0(2)	1(2)	0(1)	0(2)	0(1)
010	3(2)	3(2)	7(4)	20(6)	0(2)	0(2)	1(2)	0(1)	0(2)	0(1)
039	--	15(1)	19(4)	35(6)	1(2)	0(2)	1(2)	0(1)	3(2)	--
Tributary Streams										
Nye Creek - 016	35(1)	21(2)	5(3)	14(6)	0(2)	0(2)	0(2)	0(1)	1(2)	--
South Nye Creek - 047	250(1)	140(2)	11(3)	16(6)	1(2)	0(2)	0(2)	1(1)	9(2)	--
Silver Creek - 042	5(1)	1(2)	7(3)	8(6)	2(2)	0(2)	0(2)	0(1)	4(2)	--
Mountain View Creek - 044	2(1)	1(2)	9(3)	25(6)	3(2)	0(2)	0(2)	0(1)	4(2)	--
Verdigris Creek - 043	0(1)	1(2)	8(3)	23(6)	1(2)	0(2)	0(2)	0(1)	8(2)	--
Initial Creek - 017	--	--	8(3)	29(6)	0(2)	0(2)	0(2)	0(1)	0(1)	--
Cathedral Creek - 018	--	--	7(2)	11(6)	1(2)	0(2)	0(1)	2(1)	0(1)	--
Little Rocky Creek - 031	5(2)	9(2)	16(4)	40(6)	5(2)	5(2)	0(2)	1(1)	5(2)	--
Little Rocky Creek - 015	--	--	12(1)	21(6)	0(2)	0(2)	0(2)	0(1)	0(2)	--
Fishtail Creek - 030	2(2)	1(2)	9(4)	15(6)	1(2)	5(2)	0(2)	0(1)	1(1)	--
East Fishtail Creek - 012	1(1)	1(2)	16(3)	13(6)	1(2)	0(2)	0(2)	0(1)	0(2)	--
West Fishtail Creek - 013	2(1)	0(2)	7(3)	12(6)	1(2)	0(2)	0(2)	0(1)	0(2)	--
Picket Pin Creek - 020	--	--	1(2)	10(5)	0(2)	0(2)	0(2)	0(1)	--	0(1)
Falls Creek - 027	--	--	4(1)	9(6)	1(2)	0(2)	0(2)	0(1)	0(2)	--
Graham Creek - 025	--	0(1)	2(5)	9(6)	0(2)	0(2)	--	--	--	--
Blakely Creek - 024	5(1)	3(2)	2(4)	8(6)	0(2)	0(2)	1(2)	0(1)	0(2)	--
East Chippy Creek - 023	--	--	7(1)	11(6)	1(2)	0(2)	1(2)	0(1)	0(2)	--

a - Turbidity expressed in Jackson Turbidity Units

in South Nye Creek in March and April were caused by mill tailings freshly blown into the stream. Values for both turbidity and suspended solids tended to be greater during spring runoff at downstream points in agricultural areas. This was especially true on the West Fork Stillwater River between stations 076 (downstream of irrigated fields) and station 037 (on national forest, Appendix E).

Volatile suspended solids (Appendix L) are organic particles suspended in water. They constituted a major fraction of the total suspended solids only when total suspended solids were low. For example when total suspended solids in Appendix L were less than 1 milligram per liter, volatile suspended solids averaged 75 percent of the total. For total suspended solids values over 15 milligrams per liter, in Appendix L, volatile suspended solids averaged 11 percent of the total.

Dissolved and Suspended Metal Concentrations

Dissolved and total concentrations of metals (suspended = total minus dissolved) were measured at 11 stations on larger streams in 1973 (Appendix M), and at stations in the West Fork Stillwater River drainage in 1975 and 1976 (Appendices E and G). Even with low detection limits (varying from 0.001 to 0.05 mg/l) most samples contained metals concentrations below detection limits. For all stations and metals the proportions of dissolved and suspended were variable. For the higher values, most of the total was in the suspended fraction. With the exception of the values for the adit drainage (Appendix G), the metals concentrations are relatively low and indicative of clean, unmodified water quality.

Higher values of dissolved and especially suspended metals in the adit drainage were probably due to considerable contact of groundwater in the adit with freshly powdered and fractured rock. The discharge permit written for the adit drainage contains some stipulations concerning metals in the adit discharge.

Stream Sediment Metals

Maximum and minimum values for metals in stream sediments are shown in Table 5. More complete data are contained in Appendices N and O. These values are surprisingly similar to values for the earth's crust, which are as follows (in parts per million): copper - 45; nickel - 80, lead - 15; cadmium - 0.2; zinc - 65; iron - 50,000; aluminum - 81,300 (Wolfe and Rice 1972). This similarity suggests a relatively unmodified condition in the study streams. Spence (1975) found stream sediment values similar to those of this study, with the exception of his stations affected by mining.

The nickel values at station 006 on the Stillwater River are probably elevated above natural levels. Station 006 had stream sediment nickel values which averaged several times greater than those only a few miles upstream (station 005). The probable sources are Verdigris Creek, a small tributary carrying elevated nickel concentrations, and mill tailings, both a short distance upstream from station 006.

Table 5. Maximum and minimum values recorded for various metals in stream sediments.[a, b]

Metal	Maximum	Minimum
Copper	235 (Crescent Cr.-048)	5.5 (W. Rosebud R.-004)
Nickel	705 (Graham Cr.-025)	10 (W. Rosebud R.-004)
Lead	79.5 (Picket Pin Cr.-020)	9 (E. Rosebud R.-002, & Boulder R.-011)
Cadmium	3 (Stillwater R.-006)	<1 (most stations)
Zinc	254.5 (W.Fk.Stillwater R.-007)	16 (Blakely Cr.-024)
Iron ($X10^3$)	103 (Forge Cr.-051)	9 (W. Rosebud R.-003)
Aluminum[c] ($X10^3$)	23 (W. Fk. Stillwater R.-072)	7 (Castle Cr.-077)

[a]Stream and station number shown in parentheses
[b]Concentrations are parts per million
[c]Measured only in West Fork Stillwater River drainage

High values for nickel on some tributary streams have no obvious explanation other than mineralization in the watershed.

In general, values for all metals are somewhat lower at stations on the East and West Rosebud rivers.

Stream Temperature

Maximum-minimum temperature was measured only at stations in the West Fork Stillwater River. This was a part of more intensive work done in this drainage because of the Johns-Manville development described in the background section.

Thermometers were installed at eight stations in July 1975 and usually were read each week for 1 year. Monthly maximum and minimum temperatures are shown for each station in Table 6. Appendix P contains the individual thermometer readings.

The maximum temperature recorded was 60 F at stations 080 and 076 on Castle Creek and the lower West Fork Stillwater River. Minimum temperatures of 32 F were recorded at all stations except 080 and 077 which are strongly affected by springs.

Springs with temperatures in the 40's are located adjacent to Castle and Picket Pin Creeks on the far west side of the Picket Pin Ranch and on the Custer National Forest adjacent to the west side of the ranch (Figure 2).

Table 6. Monthly maximum and minimum water temperatures (F) recorded at stations in the West Fork Stillwater River drainage, 8/75-7/76.

	West Fork Stillwater River				Castle Creek			Picket Pin Creek
Month	076	007	037	070	080	079	077	078
8/75	57-44	55-43	53-42	53-42	58-46	56-42	51-43	52-42
9/75	56-39	54-40	51-38	50-35	58-45	56-40	52-42	53-40
10/75	54-36	50-32	48-32	48-32	54-40	53-34	46-41	48-36
11/75	44-33	43-32	40-32	39-32	50-38	47-32	44-38	44-34
12/75	43-32	40-32	37-32	36-32	47-34	43-32	44-39	42-32
1/76	41-33	37-32	36-32	34-32	47-35	43-32	43-40	41-32
2/76	42-33	37-32	36-32	34-32	47-34	43-32	43-40	41-32
3/76	47-32	40-32	39-32	37-32	52-34	49-32	45-40	44-33
4/76	54-34	47-33	43-33	44-32	59-35	57-32	47-40	48-33
5/76	55-38	51-32	48-33	48-32	56-39	56-36	50-39	48-36
6/76	53-38	52-37	51-36	50-34	56-41	53-39	51-37	50-38
7/76	60-45	58-42	55-40	55-38	60-46	58-44	54-43	54-42

These springs dampen fluctuation of stream temperatures and prevent ice cover at station 077 on Castle Creek and to a lesser extent at station 078 on Picket Pin Creek.

Station 080 is strongly affected by a large spring that empties into Lodgepole Creek about 2 miles upstream of its confluence with Castle Creek (Figure 2). The temperature of this spring is approximately 55 F. It totally prevents ice cover in the vicinity of station 080 and measurably warms the West Fork Stillwater River downstream from the mouth of Castle Creek.

Stations 070, 037 and 007 on the West Fork Stillwater River are in mountain sections of the stream and are colder than the other stations. Ice cover is nearly complete during much of the winter.

Maximum temperatures reached at all stations are at least 10 F below temperatures that begin to hamper trout growth and production.

Streambottom Macrofauna

Numbers of organisms for various taxonomic groups in each square foot sample are shown by drainage systems in Appendices Q through V. These organisms remain in storage at the Montana Department of Fish and Game Water Quality Laboratory in Helena. Unsorted qualitative Needham kick screen samples from various nonriffle habitats are in storage at the same location.

The generally pollution-sensitive insect orders Plecoptera, Trichoptera and Emphemeroptera typically constituted the bulk of organisms in samples. These three orders usually made up 60 to 90 percent of organisms in samples. In some seasons at downstream locations dipterans or annelids were numerically dominant.

Variability in numbers and volume of bottom fauna was high at most stations, but probably no more so than is characteristic of these organisms. Needham and Usinger (1956) took 100 1-square-foot samples from a single riffle. Numbers of organisms per sample ranged from 2 to 198. Data of this study are probably less variable than that reported by Needham and Usinger (1956).

Overall numbers of organisms per square foot tended to reach highest levels in winter or spring and lowest levels in summer (Appendices Q through V). Numbers were especially low in summers of 1974 and 1975. These samples were collected shortly following unusually high and late runoff periods.

Dent (1971) had also sampled bottom fauna in the same streams and at some of the same stations reported in this study. He used a Surber square-foot sampler and found consistently fewer numbers of organisms per square foot than found in this study. For comparison, the following are average numbers of organisms per square foot in October 1971 for stations on nearby portions of the Stillwater, West Fork Stillwater, East Boulder and Boulder rivers, respectively (data of Dent 1971 given first): 83 and 267, 84 and

246, 91 and 739, 106 and 402. At the same station (031) on Little Rocky Creek, the corresponding numbers are 36 and 156. Dent's (1971) data are similar to that of this study in proportions of insect orders present.

In personal correspondence with Mr. Dent, he stated he had begun using a sampler similar to that used in this study, and that the number of organisms in samples was considerably larger than the numbers taken with the Surber sampler.

Both Needham and Usinger (1956) and Waters and Knapp (1961) felt the Surber sampler had numerous shortcomings. The latter felt the Surber sampler could fail to capture all macrofauna on the portion of the stream covered by the sampler. This definitely seems to be true in comparing Dent's (1971) data with this study.

Spence (1975), using the Water's Round sampler found numbers of stream-bottom macrofauna that even averaged somewhat higher than this study. His samples were from the Blackfoot River drainage in western Montana.

Low numbers of organisms in May 1972 for some stations on the Boulder River (Appendix V) and station 035 on the Stillwater River (Appendix R) were probably caused by sampling on newly flooded streambottom. Streams were rising rapidly at the time of sample collection.

Almost complete absence of organisms in samples from station 043 on Verdigris Creek (Appendix R) is likely due to previously discussed adverse chemical conditions.

Identification of insects was done for samples from four stations on the West Fork Stillwater River and for one station on the East Boulder River. Table 7 is a summary of the number of species and genera found in each sample. Complete lists of organisms are shown in Appendix W. Many organisms could be identified only to genus and some only to family. For this reason the actual numbers of species and genera are probably somewhat larger than shown in Table 7. Even without this consideration, the number of species per square foot is high and diversity (not calculated) correspondingly high. Total numbers of species and genera per square foot are similar to Blackfoot River samples reported by Spence (1975).

Table 7. Minimal[a] number of insect genera and species (in parentheses) identified from 1-square-foot streambottom samples.

Station	Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Total
			West Fork Stillwater River				
054	7/24/73	2 (2)	2 (2)	5 (6)	3 (3)	1 (1)	13 (14)
037	5/30/73	3 (4)	5 (7)	7 (7)	2 (2)	0 (0)	17 (20)
037	5/30/73	4 (4)	4 (4)	5 (9)	3 (3)	0 (0)	16 (20)
007	5/ 3/73	5 (5)	4 (4)	7 (9)	3 (3)	1 (1)	20 (22)
036	2/ 8/72	4 (5)	5 (6)	7(10)	6 (6)	1 (1)	23 (28)
			East Boulder River				
009	5/ 2/73	5 (5)	6 (7)	5(10)	b	1 (1)	17 (23)[c]
009	5/ 2/73	4 (4)	6 (7)	6 (9)	b	2 (2)	18 (22)[c]
009	5/ 2/73	5 (5)	7 (8)	4 (7)	b	2 (2)	18 (22)[c]

[a]Number of species are minimal because some genera consisted of an unknown number of species. Also, some families consisted of an unknown number of genera.

[b]Three samples at station 009 were grouped. A total of six genera and six species were identified from the three samples.

[c]Diptera not included.

Fish Populations

Table 8 is a summary of physical characteristics, fish species captured, and fin clips made on fish in stream sections. Section locations are shown in Figures 1 and 2. These stream sections were used for estimation of fish population parameters.

Fish population data are given in Appendices X and Y. The length groups, fish ages in each length group and numbers of fish per length group are shown in Appendix Z. Estimates for some species shown in a previous report are not shown in Appendices X and Y because reexamination of the data indicated the number of recaptured fish was not sufficient for a reliable estimate. Some estimates made in 1971 and 1972 differ slightly from a previous report (Stewart 1973). These differences are due to recalculation of the estimates using a slightly refined computer program.

Hatchery fish were captured in small numbers at only two locations, despite the fact that they were stocked in all of the larger streams. A few hatchery rainbow trout were noted in section F-2, Stillwater River in 1973, but not in 1972 or 1974. Hatchery cutthroat trout are present in the upper reaches of the East Boulder River where fish were not present before these were stocked.

Number estimates in stream sections were not made for species captured infrequently, nor in some cases for young-of-the-year fish of species that were estimated. Very small fish are sampled inefficiently by electrofishing gear. Table 9 is a listing of numbers of young-of-the-year fish captured in electrofishing sections, for sections where no estimate was made for young-of-the-year. In 7 of the 28 electrofishing sections, no young-of-the-year fish were captured. They were probably present, but were not captured because of insufficient effort or extremely small size of the fish, or both.

Fish ages shown in tables and appendices are the number of annuli on scales. Except for fish captured in June, when annuli were formed, fish had experienced some portion of a growing season beyond the indicated age. Rainbow trout in the West Fork Stillwater River upstream from Castle Creek often failed to form the first annulus, probably because of late spawning and slow growth. This fact was recognized by finding two distinct size groups of fish (young-of-the-year and yearling), each lacking an annulus, and by the difference in position of the first annulus formed, between those fish forming the age I annulus and those failing to form it. Fish failing to form the first annulus were assigned the proper age by adding one to the number of annuli on scales.

Growth rates, while generally slightly slower than state averages reported by Brown (1971) are commensurate with the relatively low summer water temperatures and resultant short growing seasons.

Standing crops of trout in pounds per acre (Appendices X and Y) on larger streams are somewhat lower than those reported by Vincent (1969) for rivers in southwestern Montana. Some of the tributary streams had

Table 8. Miscellaneous data for electrofishing sections where fish population estimates were made.

Stream	Section Number	Location T	Location R	Location S	Length (Feet)	Mean Width (Feet)	Species Present[a]	Fin Clips Used
Little Rocky Creek	F-8	5S	16E	3,4	2590	13.9	Rb,LL,Ct	1972-adipose plus right pelvic 1973-right pectoral; 1974-temporary
Picket Pin Creek	F-16	4S 4S	15E 14E	30 25	2059	13.5	Ct,Eb, LL,Rb	1972-adipose; 1973-left pelvic 1975-temporary
West Fork Stillwater River	F-22	5S	14E	30	4404	29.2	Rb	1974-adipose
West Fork Stillwater River	F-28	5S	14E	14,15 22	3146	30[b]	Rb	1975-left pelvic
West Fork Stillwater River	F-26	5S	14E	11,12,14	2818	30.0	Rb,LL	1975-adipose; 1976-temporary
West Fork Stillwater River	F-29	5S	14E	12	1626	41.2	Rb,LL	1975-right pelvic
West Fork Stillwater River	F-17	4S	15E	33	2293	41.2	Rb,LL Wf	1973-adipose; 1974-left pelvic
West Fork Stillwater River	F-24	4S	15E	36,35 26	3600	43.0	Rb,LL Wf,Eb	1974-temporary
Castle Creek	F-25	4S 4S	15E 14E	30 25	1300	6.6	Ct,LL Eb	1975-(spring)-right pelvic 1975-(fall)-temporary
Castle Creek	F-27	4S	15E	29	2789	18.0	LL	1975-left pelvic
Castle Creek	F-23	4S	15E	28	2604	15.8	LL,Rb	1975-(spring)-adipose 1975-(fall)-temporary
Lower Deer Creek	F-18	2S	15E	16,17 20	6160	25.2	Rb,Ct,hybrid Eb,LL	1973-adipose

Table 8. continued ( ). Miscellaneous data for electrofishing sections where fish population estimates were made.

Stream	Section Number	Location T	Location R	Location S	Length (Feet)	Mean Width (Feet)	Species Present[a]	Fin Clips Used
Boulder River	F-4	3S	12E	26, 35	5236	81.4	Rb,Eb Lc	1972-adipose; 1973-left pelvic 1974-temporary
Boulder River	F-21	5S	12E	13, 24	3329	58.8	Rb,Eb,Ct,LNd Rb-Ct hybrid	1974-adipose
East Boulder River	F-13	4S	13E	2,11	2410	28.2	Rb,Ct,LL	1972-adipose 1973-right pelvic
East Boulder River	F-20	3S	13E	29	2823	37.8	Rb,Eb,LL	1974-left pelvic
East Rosebud River	F-14	6S	18E	19,20	6283	77.6	Rb,LL,Wf *Catostomus* sp.	1971-temporary
Morris Creek	F-12	6S	18E	8	1347	8.4	Eb,LL,Ct LNd	1972-left pelvic 1973-adipose
West Fishtail Creek	F-10	5S	17E	19	2270	20.3	Rb,Eb,LL	1972-right pelvic 1973-right pectoral + adipose
East Fishtail Creek	F-9	5S	17E	19	2073	14.8	Rb,Eb,LL	1972-right pectoral 1973-left pelvic
Fishtail Creek	F-11	5S	17E	8,17, 18	3948	27.5	Rb,Eb,LL Wf	1972-adipose 1973-left pectoral
Stillwater River	F-1	5S	15E	28	2986	109.6	Rb,Eb,LL,Wf LNSu,LNd,MSu	1972-right pelvic 1973-adipose
Stillwater River	F-2	5S	15E	10,11 15	6710	91.6	Rb,Eb,LL,Wf LNSu,MSu,LNd	1972-adipose; 1973-left pelvic 1974-temporary
Stillwater River	F-3	5S	15E	1,2	5578	82.5	Rb,Eb,LL Wf,LNSu	1971-temporary

Table 8. continued ( ). Miscellaneous data for electrofishing sections where fish population estimates were made.

Stream	Section Number	Location T	Location R	Location S	Length (Feet)	Mean Width (Feet)	Species Present[a]	Fin Clips Used
Stillwater River	F-19	4S	16E	23	1982	124.0	Rb,Eb,Ll,Ct, Wf,LNSu,MSu, LNd	1974-adipose
Silver Creek	F-7	5S	15E	15	1289	6.4	Rb,Eb,LL	1972-left pectoral; 1973-adipose plus left pelvic; 1974-temporary
Nye Creek	F-6	5S	15E	15	1453	5.0	Rb,Eb,LL	1972-right pectoral; 1973-adipose plus right pectoral; 1974-temporary
Mountain View	F-5	5S	15E	21	2589	4.8	Rb,Eb,LL LNd,LNSu	1972-adipose plus left pelvic 1973-right pelvic; 1974-temporary

a/ Abbreviations are: Rb-rainbow trout; Ct-cutthroat; Eb-brook trout; LL-brown trout; Wf-mountain whitefish; LNSu-longnose sucker; MSu-mountain sucker; LNd-longnose dace; Lc-lake chub

b/ Estimated

Table 9. Length range and number of young-of-year (age 0) fish captured in electrofishing sections, for sections where no estimate was made for young-of-year.[a]

Stream	Section Number	Date	Species	Number Captured[b]	Length Range (inches)
Little Rocky Creek	F-8	06-72	LL	0	-
		07-73	LL	32	2.1-3.1
East Rosebud		07-74	LL	0	-
	F-14	11-71	LL	16	2.7-4.1
Morris Creek	F-12	06-72	Eb	31	1.5-2.7
		06-73	Eb	41	1.8-2.1
West Fishtail Creek	F-10	07-72	Eb	0	-
		07-73	Eb	1	2.9
East Fishtail Creek	F-9	07-72	Eb	0	-
		07-73	Eb	0	-
Fishtail Creek	F-11	07-72	Rb	0	-
		08-73	Rb	2	1.9-2.3
		07-72	LL	0	-
		08-73	LL	3	2.3-2.5
Stillwater River	F-3	11-71	LL	0[c]	-
Nye Creek	F-6	06-73	Eb	0	-
Mountain View Creek	F-5	06-72	Eb	0	-
		06-73	Eb	3	1.9-2.2
Picket Pin Creek	F-16	09-72	Eb	5[d]	2.3-3.5
		09-73	Eb	105	2.1-3.2
		09-72	LL	1	2.2
		09-73	LL	4	2.0-2.1
		09-75	LL	1	2.6
		09-72	Ct	9	2.6-3.4
		09-73	Ct	31	2.6-3.4
West Fork Stillwater River	F-17	05-73	Rb	36	1.5-2.6
		05-74	Rb	23	1.7-2.8
		05-73	LL	26	2.1-3.2
		05-74	LL	14	2.4-3.2
West Fork Stillwater River	F-22	10-74	Rb	10	2.3-3.1
West Fork Stillwater River	F-28	10-75	Rb	0	-

Table 9 continued ( ). Length range and number of young-of-year (age 0) fish captured in electrofishing sections, for sections where no estimate was made for young-of-year.[a]

Stream	Section Number	Date	Species	Number Captured[b]	Length Range (inches)
West Fork Stillwater River	F-26	05-75	Rb	24	1.2-1.7
		04-76	Rb	1[d]	1.5
West Fork Stillwater River	F-29	11-75	Rb	0	-
West Fork Stillwater River	F-24	04-75	Rb	49	1.7-2.8
Lower Deer Creek	F-18	07-73	LL	0	-
East Boulder River	F-13	08-72	Rb	5	2.3-3.3
		08-73	Rb	15	2.3-3.0
		08-72	LL	0	-
		08-73	LL	0	-
East Boulder River	F-20	09-74	Rb	0	-
		09-74	LL	0	-
Castle Creek	F-27	09-75	LL	75	2.0-2.6

a/ Number of recaptures insufficient for estimate of total numbers present.

b/ Total of marking and recapture runs.

c/ No efforts made to catch age 0 fish.

d/ More observed, but not recorded.

moderately high trout standing crops. Carlander (1953) reports standing crop values for trout streams in North America to be largely in the range of 10 to 150 pounds per acre, with an approximate median of 60. Compared to Carlander's (1953) data, standing crops of trout in streams of this study range from moderately low to high.

Total estimates in Appendices X and Y suggest considerable variation in standing crops of trout from year to year in many of the stream sections. This may be misleading. In 1973 and 1974 an estimate for yearling or under-yearling fish was added in the total estimate, if adequate numbers of fish were sampled. In 1972 an estimte for these younger fish was often lacking in the total estimate, because adequate numbers were not sampled. Also, a consideration of confidence limits minimizes apparent differences in standing crops between years. For example, on Section F-1, Stillwater River, the mean total estimates of brook trout for 1972 and 1973 were 422 and 800. However, by considering the highest probable value in the 1972 estimate (612), and the lowest probable value in the 1973 estimate (597), it is evident that there is overlap in the ranges of probable fish numbers for the 2 years. However, even with these considerations there are definite differences among years in some stream sections for numbers of under-yearling and yearling fish.

There was generally good agreement between average lengths of fish of a given age from year to year (Appendices X and Y). For the few cases where differences were relatively large, average sizes were calculated from very small samples of fish.

Age structures in Appendices X and Y were mostly typical. Some of the small imbalances can be explained on the basis of confidence intervals, but larger imbalances are probably real. These imbalances can occur by differential year class survival and migration, but no certain explanation can be confidently advanced.

Almost no movement was noted from one stream section to another from year to year. Minor exchange of fish occurred only between sections on Fishtail Creek (F-11), East Fishtail Creek (F-9) and West Fishtail Creek (F-10). These sections are separated by less than 1 mile.

Spawning movement of fish was not investigated. It was observed only incidentally in the Stillwater River in the vicinity of section F-2. Unknown, but significant, numbers of large rainbow trout moved into this section between the time of marking runs in late March and recapture runs in April. Whether or not these fish later spawned in section F-2 or were simply passing through is not known. Some sort of spawning movement, however, did seem to be occurring in this area of the Stillwater River.

A complicating factor has been introduced on section F-2 of the Stillwater River. In March 1973 over one-third of the length of this section was modified by adjacent landowners, largely by pushing streambed gravel into streambanks. Part of this modification occurred a few days prior to the 1973 fish population estimate, and part of it while the estimate was being made. From 1972-1974, pounds per acre of brown trout have gone from 20.6 to 15 to 8.7; the corresponding figures for brook trout are 2.3, 2.7 and 0.9 (Appendix X). Numbers of older fish show the greatest decrease.

No work was done with the mountain whitefish except to note their presence (Table 8). They are found in most of the larger streams at elevations below approximately 5500 feet.

Fish populations were also investigated where estimates were not made (survey electrofishing, Appendix AA). This work was done to determine species present and to get rough information on fish numbers. In the smaller tributary streams, fish tend to be present in small numbers only near the mouth, if they are present at all. The upper reaches of some smaller streams were not survey electrofished. It was assumed that fish were absent in an upstream reach if they were not present in a downstream reach.

Silver Creek is an exception. Here fish are present from the mouth upstream to springs which are the source of the stream.

Upper reaches of most smaller streams are extremely steep, becoming a series of cascades and plunge pools. Some of these streams probably dry up in winter. Some of the small streams accessible during winter were checked for water flow near the mouth following severe weather. Verdigris and Initial creeks were dry. Cathedral and Falls creeks had water flow. Crescent Creek is dry much of the year.

Cutthroat trout were stocked in upper Iron Creek and the East Boulder River in Placer Basin in 1971, when other Fish and Game Department personnel found that fish were not present. Considerable electrofishing in Iron Creek in 1974 did not recapture any of these fish or their offspring. A few of the fish planted in the upper East Boulder River are still present, but their numbers seem to be decreasing and no evidence of reproduction has been found (Appendix AA). A single hatchery cutthroat trout found in the mouth of Forge Creek was from the plant made in the upper East Boulder River.

Fish Population Stability

Stability, as used here, indicates the percentage of fish present in a stream section in year X that remained in the section in year X+1, with mortality calculations for that period considered. Percentages were calculated for 12 stream sections where data were sufficient to make the appropriate calculations (Table 10). Stability for all stream sections and species averaged 55 percent for 1972-1973, 59 percent for 1973-1974, 74 percent for one section for 1975-1976, and 79 percent for two sections on Castle Creek from spring 1975 to fall 1975.

These percentages indicate that the majority of fish in stream sections are residents and not merely passing through the sections at the time of electrofishing.

Precision of the stability estimates is similar to the precision of population estimates (Appendices X and Y) which were used in the calculation of stability.

Table 10. Number of fish marked in 1972 or 1973, number of recaptures one year later, and stability[a] of fish populations in stream sections.

Stream	Section Code	Species	Age 1973	Age 1974	Number marked 1972	Number marked 1973	Recaptures of fish marked one year previous 1973	Recaptures of fish marked one year previous 1974	Stability (percent) 1973	Stability (percent) 1974
Morris Creek	F-12	Brook	II		176		29		42	
		trout	III		60		21		87	
Fishtail Creek	F-11	Rainbow	III		51		33		81	
		trout	IV and older		31		19		95	
		Brown	III		40		34		68	
		trout	IV and older		52		27		66	
Little Rocky	F-8	Brown	-	II	-	29	-	1	11	
Creek		trout	III and older	III and older	104	50	34	5	46	30
Stillwater River	F-2	Brown	II	II	91	174	12	12	32	27
		trout	III	III	124	81	29	25	42	34
			IV and older	IV and older	142	115	21	14	66	62
Silver Creek	F-7	Brown		I	-	202	-	36	-	59
		trout	II	II and older	82	220	13	72	18	~100
			III		50		13		70	
Picket Pin Creek	F-16	Brook trout	II and older		77		31		54	
		Brown	II		16		11		65	
		trout	III		34		15		70	
			IV and older		37		5		50	
		Cutthroat	II		15		13		~100	
		trout	III and older		20		17		86	
West Fork Stillwater River	F-17	Rainbow		II		106		43		85
		trout		III		43		27		83
				IV and older		87		19		91
		Brown		II		15		8		58
		trout		III and older		22		8		80
East Boulder River	F-13	Rainbow	III		55		26		91	
		trout	IV		115		93		81	
			V and older		44		13		41	
		Brown	IV		24		16		92	
		trout	V and older		13		12		92	

Table 10 continued ( ). Number of fish marked in 1972 or 1973, number of recaptures one year later, and stability[a] of fish populations in stream sections.

Stream	Section Code	Species	Age 1973	Age 1974	Number marked 1972	Number marked 1973	Recaptures of fish marked one year previous 1973	Recaptures of fish marked one year previous 1974	Stability (percent) 1973	Stability (percent) 1974
Boulder River	F-4	Rainbow trout	II		27		1		8	
			III	III	25	17	5	1	24	20
			IV and older	IV and older	61	164	7	31	24	43
		Brook trout	I	-	185	-	10	-	23	-
			II	-	274	-	9	-	12	-
			III	-	52	-	1	-	8	-

Stream	Section Code	Species	1976	1975	1976	1976
West Fork Stillwater River	F-26	Rainbow trout	II	40	11	69
			III	40	27	86
			IV and older	52	14	66

Stream	Section Code	Species	Fall 1975	Spring 1975	Fall 1975	1975
Castle Creek	F-25	Brook[b] trout	I	223	112	86
			II	21	14	77
		Brown[b] trout	I	19	8	70
			II and older	49	40	82
Castle Creek	F-23	Brown trout[b]	I	396	67	68
			II and older	606	382	91

a/ Stability, as used here, indicates the precentage of fish present in the stream section in year X that remained in the section in year X+1, with mortality calculations for that period considered.

b/ Stability percentages are for a six month period rather than one year.

Table 11. Characteristics of brook trout and brown trout redds in the West Fork Stillwater River, Castle Creek and Picket Pin Creek.

Date	Species	Redd No.	Depth (feet)	Gravel diameter (inches)	Velocity (feet per second) at 0.6 of depth
		Castle Creek near station 077			
10-24-75	Brook trout	1	0.3	0.5-2.0	0.69-0.99
10-24-75	Brook trout	2	0.5-0.6	0.5-3.0	1.38-1.54
10-24-75	Brook trout	3	0.15-0.3	0.5-4.0	0.73-1.44
11-07-75	Brown trout	4	0.5	0.5-2.0	0.45
		Castle Creek near station 079			
11-07-75	Brown trout	1	0.7	0.5-4.0	1.20
11-07-75	Brown trout	2	0.4	0.5-2.0	2.20
11-07-75	Brown trout	3	0.5	course sand-2.0	1.05
11-07-75	Brown trout	4	0.4	0.5-2.0	1.15
11-07-75	Brown trout	5	0.4	0.5-3.0	1.08
11-07-75	Brown trout	6	0.6	0.5-4.0	2.10
11-07-75	Brown trout	7	0.55	0.5-2.0	1.55
11-07-75	Brown trout	8	0.5	0.5-2.0	1.00
		Castle Creek near station 080			
11-07-75	Brown trout	1	0.4	0.5-2.0	0.85
11-07-75	Brown trout	2	0.55	0.5-2.0	1.25
11-20-75	Brown trout	3	0.6	<2.0	0.42
11-20-75	Brown trout	4	0.5	<2.0	1.82
11-20-75	Brown trout	5	0.5	<3.0	1.10
11-20-75	Brown trout	6	0.8	1.0-2.0	0.42
11-20-75	Brown trout	7	1.0	1.0-2.0	0.30
11-20-75	Brown trout	8	0.8	1.0-2.0	1.70
11-20-75	Brown trout	9	0.5	1.0-2.0	2.00
11-20-75	Brown trout	10	0.4	1.0-2.0	0.62
11-20-75	Brown trout	11	0.45	1.0-2.0	0.90
11-20-75	Brown trout	12	0.3	-	1.80

Table 11 continued ( ). Characteristics of brook trout and brown trout redds in the West Fork Stillwater River, Castle Creek and Picket Pin Creek.

Date	Species	Redd No.	Depth (feet)	Gravel diameter (inches)	Velocity (feet per second) at 0.6 of depth
		Picket Pin Creek near station 078			
10-24-75	Brook trout	1	0.2-0.4	coarse sand-2.0	0.88
10-24-75	Brook trout	2	0.2-0.3	coarse sand-2.0	0.55
		West Fork Stillwater River near station 076			
11-25-75	Brown trout	1	0.5	0.25-2.0	1.15
12-02-75	Brown trout	2	0.55	0.5-3.0	1.60

Table 12. Percentage survival to hatching of eyed cutthroat (1972 and 1976) and eyed rainbow (1973-1975) trout eggs placed in artificial redds.

Station Number	Date eggs placed in redds	Date eggs removed from redds	Percentage survival in egg containers 1	2	3	Mean survival
East Rosebud River						
001	4-20-72	05-15-72	51	39	33	41
001	9-19-73	10-04-73	96	91	81	89
028	4-20-72	05-15-72	43	-	-	-
028	9-19-73	10-03-73	80	98	73	84
West Rosebud River						
003	4-20-72	05-15-72	27	34	34	32
003	9-19-73	10-04-73	84	76	79	80
004	4-20-72	05-15-72	69	63	62	65
004	9-19-73	10-03-73	97	90	89	92
Stillwater River						
005	4-19-72	05-16-72	42	47	51	47
005	9-19-73	10-03-73	92	88	89	90
005	9-14-74	10-05-74	91	94	93	93
006	4-19-72	05-16-72	7	-	-	-
006	9-19-73	10-03-73	85	86	89	87
006	9-14-74	10-03-74	85	90	96	90
West Fork Stillwater River						
070	9-03-75	10-06-75	77	75	70	74
070	7-08-76	07-23-76	81	68	-	75
075	7-08-76	07-20-76	90	86	-	88
037	9-14-74	10-18-74	87	89	92	89
037	9-03-75	10-06-75	65	76	62	68
007	4-19-72	05-16-72	50	59	51	53
007	9-19-73	10-11-73	66	85	78	76
007	9-14-74	10-10-74	81	74	81	79
076	9-03-75	09-22-75	66	54	67	62
036	9-14-74	10-03-74	82	87	70	80
Castle Creek						
077	9-03-75	10-01-75	74	46	82	67
079	9-03-75	09-30-75	44	64	45	51
080	9-03-75	09-25-75	77	62	65	68
Picket Pin Creek						
078	9-03-75	10-01-75	58	68	56	61

Table 12 continued ( ). Percentage survival to hatching of eyed cutthroat (1972 and 1976) and eyed rainbow (1973-1975) trout eggs placed in artificial redds.

Station Number	Date eggs placed in redds	Date eggs removed from redds	Percentage survival in egg containers 1	2	3	Mean survival
East Boulder River						
038	9-14-74	10-23-74	83	57	61	67
061	9-13-74	10-17-74	73	68	57	66
008	4-19-72	05-17-72	40	-	-	-
008	9-18-73	10-08-73	66	78	85	76
008	9-13-74	10-14-74	82	86	75	81
Boulder River						
010	9-18-73	10-05-73	79	70	75	75
010	9-13-74	10-09-74	85	84	81	83
011	9-18-73	10-12-73	90	73	81	81
011	9-13-74	10-14-74	87	81	78	82

Trout Spawning and Early Life History

This work was done only in the West Fork Stillwater River drainage. Attempts were made to locate redds, measure their physical characteristics, and determine approximate egg hatching dates. Data are shown in Table 11. Rainbow trout are present in the West Fork Stillwater River, but no redds were located. Spawning probably occurred in May and June when streamflows were high and redds difficult to locate. Brown trout occur in the system only in the West Fork Stillwater River below the confluence of Castle Creek. Only two redds were found here. Brook trout reside only in lower Picket Pin Creek and in Castle Creek upstream of the confluence of Picket Pin Creek.

Water depths and velocities over redds and gravel sizes in redds were similar at all locations regardless of stream size (Table 11). Redds were always located in shallow water. One redd was found in water 1 foot deep, but most were located in water depths of approximately 0.5 feet. Pools were never used for redd construction.

Construction of brook trout redds was first observed on October 20, 1975 in Castle and Picket Pin creeks. Spawning activity was over by the end of October. Brown trout redd construction began by November 7, 1975. Spawning appeared to be essentially completed by December 1, 1975.

Brook trout eggs in Castle Creek were all hatched by January 30, 1976. The fry remained in redd gravels on March 10, 1976. No further observations were made, but swim-up probably occurred soon after March 10, as the yolk sac was mostly absorbed. No observations were made on brook trout egg hatching in Picket Pin Creek, but it is probably somewhat later than brook trout in Castle Creek as water temperatures are lower.

Brown trout egg hatching began near March 10, 1976 in Castle and Picket Pin creeks on the Picket Pin Ranch (vicinity stations 077 and 078), and about this same time in Castle Creek downstream from Lodgepole Creek (vicinity station 080). The last observation of brown trout eggs on Castle Creek upstream of Lodgepole Creek (vicinity station 079) was made on April 8, 1976. No eggs observed had hatched by this date, but hatching probably occurred soon afterwards.

Brown trout eggs in the lower West Fork Stillwater River (vicinity station 076) began hatching in early April 1976. Some eggs had hatched on April 8, 1976. This was the last observation, but hatching was probably complete by the end of April.

Egg Bioassays

Overall average survival of eyed trout eggs placed in artificial redds (Table 12) was considerably higher in 1973, 1974 and 1975 (83, 81 and 64 percent) than in 1972 (45 percent). Differences in conditions and procedures between the years were: rainbow trout eggs used in 1973 through 1975 and cutthroat trout eggs in 1972; gravel chips placed in egg containers in 1973 through 1975, but not in 1972; September-October

incubation in 1973 through 1975 and April-May incubation in 1972. The second factor may have had some importance, but the last seems most significant.

Water temperatures were probably more favorable during the September-October period. Although maximum-minimum thermometers were not used in 1972 and 1973, spot measurements with a pocket thermometer showed considerable periods of water temperatures in the suboptimal range of 32-39 F in 1972. In 1973 no water temperatures below 40 F were observed, although they may have occurred for short periods at some stations.

In 1974 maximum-minimum thermometers were used at some of the stations during egg incubation. Also, eggs were placed at some high elevation stations not used in 1973. For 1974 at two stations where minimum temperatures did not go below 40 F, survival averaged 91.5 percent. For three stations where a minimum temperature of 36 F was recorded, survival averaged 81 percent. At one station the minimum temperature was 32 F and survival was 67 percent. In conclusion, temperatures above 39 F seemed important for survival to hatching.

Methods used in 1975 were identical to those used in 1973 and 1974, but survival was somewhat less in 1975 (64 percent vs. 83 and 81 percent). The percentages may not be directly comparable, however, because there was only one station in common between 1975 and 1974 and none between 1975 and 1973. Also in 1975, temperatures below 40 F were not related to egg survival, but temperatures in this range occurred at only two stations and the lowest temperature recorded was only 36 F.

Effect of egg transport from hatchery to artificial redds was negligible. Over 96 percent of control eggs, transported to the field but subsequently returned to the hatchery for incubation, survived to hatching in 1972 through 1974. In 1975 these eggs were destroyed before reaching hatching stage. However, 99 percent were still alive when they were destroyed and only 1 or 2 days remained until the expected hatching date.

Eggs in 1973 required fewer days of incubation in artificial redds because they were not taken from the hatchery until 3 or 4 days after reaching eyed stage. Eggs used in other years were placed in redds the day after eyeing.

In 1972 spring runoff began the last few days that eggs were in redds. This caused complete loss of egg containers at stations 010 and 011, and partial loss at stations 006, 008 and 028.

In 1973 the small number of eggs (10 or 20) used in vials was not sufficient to indicate complete hatching of eggs in screen containers. Consequently, although all eggs had hatched in vials, some screen containers were removed from redds before all eggs had hatched. Had these eggs been left in redds until hatching, average survival at stations 005,

008 and 010 would have been 3, 8 and 6 percent higher, respectively, than shown in Table 12. This problem was largely solved in later bioassays by leaving screen containers in redds for 2 or 3 days after all eggs were hatched in vials.

Only two bioassays were done in 1976 (Table 12). The West Fork Stillwater River (station 070) bioassay was used as a control to test toxicity of the adjacent adit drainage (station 075). No toxicity was evident.

Metals Concentrations in Fish Muscle Tissue

Concentrations of various metals in fish muscle tissue are shown in Appendix BB. In general, the precision of the determinations is plus and minus the detection limit. Detection limits for the various metals were different for different samples of fish analyzed at different times. Due to laboratory procedures, no great reliance should be placed on values for lead and nickel for samples collected in 1972.

It was the opinion of Environmental Protection Agency personnel that the levels of metals are well below values that could be hazardous to humans consuming the fish.

There is one possible exception to the preceding statement. The mercury values for fish collected in September 1973 from section F-17 on the West Fork Stillwater River are considerably higher than would be expected in unpolluted waters. These values, however, are probably not correct. A later sample was collected in October 1975. Only one of these fish has been analyzed for mercury (Appendix BB); the value obtained was low and did not agree with high mercury values found in the first sample. Also, much lower values for mercury were found in other sections of the West Fork Stillwater River.

Results of mercury analysis from the remainder of the October 1975 collection from section F-17 will be included as a supplement to this report if they are received in time.

Average values for nickel in trout in section F-2 of the Stillwater River were twice the values for the upstream section F-1 (2.0 and 1.0 micrograms per gram, using only values above the detection limit). Although no great reliance should be placed on the absolute values of the numbers, the difference is at least suggestive of an increase at the downstream location. An even greater difference was noted for nickel in stream sediments (stations 006 and 005, Appendix N). Values for nickel dissolved and suspended in water were similarly low at both stations (Appendices B and M). The probable sources of nickel were discussed in the general chemical water quality section. In conclusion, the metals in stream sediments may be related to metals in fish tissue.

Fish Stomach Contents

Approximately 12 fish stomachs per stream section were examined from sections of the Stillwater, Boulder and East Boulder rivers. This analysis was made to find organisms which might be of special importance as fish food. A wide variety of organisms was found in stomachs. No particular bottom fauna species appeared to be of great significance as fish food. In stomachs containing several organisms, two or more species were always present. Many more fish stomachs would have to be examined to reach any firm conclusion concerning fish foods.

Minimum Streamflow Reservations

Minimum streamflows requested for study area streams are shown in Table 13. These streamflows were requested under the state law, "Montana Water Use Act," section 89-890. Flows were requested only for streams in the study area having significant fish populations. These flows have yet to be approved. It is unknown at this time what action will be taken by the state with respect to the flows requested.

Streamflow measurements were made periodically at seven stations in the West Fork Stillwater River drainage (Table 14) to supply flow data for making streamflow reservation requests. Flows were also measured at times when streams were thought to be near annual minimums on the following streams: East and West Fishtail creeks, Fishtail Creek, Little Rocky Creek, and the East Boulder River. Flow data published by the U. S. Geological Survey were already available for the Stillwater, Boulder and East Boulder rivers.

Streamflows requested in Table 13 will not decrease the availability of water for the present level of existing uses, of which irrigation is probably the largest.

Amounts of water requested for the November-April period are near average annual minimum flows, except for the West Fork Stillwater River upstream of the mouth of Castle Creek. Requested flows here are somewhat higher. Flows requested for May through October are no greater than, and in some cases less than, average monthly minimum flows.

From the Water Surface Profile (WSP) program, it was found that the winter low flows naturally occurring in streams were near the minimum required to maintain fish populations. Young-of-the-year fish habitat (shallow, low velocity water at stream margins) was the first to be lost at lesser flows. Habitat for adult fish usually began to degrade only at flows below those that degraded young-of-the-year habitat.

ADDITIONAL STUDIES NEEDED

1. The mountain whitefish is common in the lower portions of the larger streams, but no work was done with this species other than to note its presence. Its status, population structure and movements should be investigated.

Table 13. Minimum streamflows (in cubic feet per second) requested of the Montana Department of Natural Resources for streams in the Stillwater and Boulder River drainages.[a]

	J	F	M	A	M	J	J	A	S	O	N	D
West Fishtail Creek - from mouth of East Fishtail Creek (T5S,R17E,S19) to the Rickman-Kennedy ditch headgate (T5S,R16E,S27)	4	4	4	4	10	20	10	4	4	4	4	4
East Fishtail Creek - from mouth of West Fishtail Creek (T5S,R17E,S19) to the mouth of the East Fork of East Fishtail Creek (T5S,R16E,S26)	4	4	4	4	7	12	7	4	4	4	4	4
Fishtail Creek - from confluence of East and West Fishtail Creeks (T5S,R17E, S19) to mouth (T4S,R18E,S28)	10	10	10	10	14	24	14	10	10	10	10	10
Little Rocky Creek - from mouth (T4S,R16E,S28) to crossing of Forest Service Road 1414 (T5S,R16E,S21)	4	4	4	4	6	8	6	4	4	4	4	4
Stillwater River - from mouth of West Fork Stillwater River (T4S,R16E,S31) to the north end of Sioux Charlie Lake (T6S,R14E,S1)	45	45	45	45	150	710	480	175	120	100	45	45
Stillwater River - from mouth of Rosebud River (T3S,R19E,S31) to mouth of West Fork Stillwater River (T4S,R16E,S3)	75	75	75	75	190	1200	760	350	275	180	75	75
Stillwater River - from mouth (T2S,R20E,S29) to mouth of Rosebud River (T3S, R19E,S31)	225	225	225	225	560	2075	1480	740	630	440	225	225
West Fork Stillwater River - from Sweet Grass - Stillwater County Line (T5S, R14E,S1) to mouth of Tumble Creek (T5S,R14E,S29)	25	25	25	25	25	200	100	40	25	25	25	25
West Fork Stillwater River - from mouth of Castle Creek (T4S,R15E,S26) to Stillwater - Sweet Grass County Line (T5S,R15E,S6)	30	30	30	30	60	300	110	65	50	45	30	30
West Fork Stillwater River - from mouth (T4S,R16E,S31) to mouth of Castle Creek (T4S,R15E,S26)	35	35	35	35	70	350	125	75	60	50	50	35
Castle Creek - from mouth of Picket Pin Creek (T4S,R15E,S30) to a point 1500 stream feet upstream (T4S,R14E,S25)	1	1	1	1	2	8	5	3	2	2	1	1

Table 13 continued ( ). Minimum streamflows (in cubic feet per second) requested of the Montana Department of Natural Resources for streams in the Stillwater and Boulder River drainages.[a]

	J	F	M	A	M	J	J	A	S	O	N	D
Castle Creek - from mouth of Lodgepole Creek (T4S,R15E,S28) to mouth of Picket Pin Creek (T4S,R15E,S30)												
	8	8	8	8	10	40	20	12	10	9	8	8
Castle Creek - from mouth (T4S,R15E,S26) to mouth of Lodgepole Creek (T4S, R15E,S28)												
	15	15	15	15	25	60	30	22	22	20	20	15
Picket Pin Creek - from mouth (T4S,R15E,S30) to mouth of Swamp Creek (T4S, R14E,S25)												
	5	5	5	5	7	25	10	8	6	6	5	5
East Boulder River - from mouth of Dry Fork (T4S,R13E,S11) to mouth of Brownlee Creek (T4S,R13E,S26)												
	10	10	10	10	14	120	36	16	14	13	10	10
East Boulder River - from mouth (T2S,R13E,S33) to mouth of Dry Fork (T4S,R13E, S11)												
	15	15	15	15	20	165	50	22	20	18	15	15
Boulder River - from mouth of Falls Creek (T4S,R12E,S15) to mouth of Howley Creek (T5S,R12E,S35)												
	40	40	40	40	75	540	240	101	72	56	40	40
Boulder River - from mouth of West Boulder River (T2S,R13E,S15) to mouth of Falls Creek (T4S,R12E,S15)												
	50	50	50	50	150	1080	480	200	145	115	50	50
Boulder River - from mouth (T1N,R14E,S12) to mouth of West Boulder River (T2S, R13E,S15)												
	80	80	80	80	300	1690	565	185	195	200	80	80

a/ Requested under the state law "Montana Water Use Act," section 89890.

Table 14. Streamflow at stations on the West Fork Stillwater River, Castle Creek and Picket Pin Creek, 1975-1976.

West Fork Stillwater River					
Station 076		Station 007		Station 070	
Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
08-06-75	169	08-06-75	160	08-04-75	132
08-21-75	116	08-21-75	103	08-21-75	78
09-05-75	96	09-08-75	63	08-29-75	52
09-29-75	79	09-29-75	45	09-30-75	25
10-20-75	77	10-20-75	44	10-29-75	21
11-24-75	57	12-01-75	36	11-14-75	17
12-24-75	56	12-09-75	30	12-09-75	13
01-14-76	49	01-12-76	23	01-14-76	12
02-18-76	39	02-19-76	20	02-19-76	8
03-16-76	38	03-16-76	16	03-16-76	7
04-06-76	37	04-08-76	23	04-08-76	11
04-23-76	50	04-26-76	25	04-20-76	13
05-05-76	101	05-05-76	54	05-04-76	28
				05-20-76	249

Castle Creek						Picket Pin Creek	
Station 080		Station 079		Station 077		Station 078	
Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
07-16-75	124	07-17-75	79	07-17-75	20	07-17-75	47
07-31-75	68	07-30-75	28	07-31-75	12	07-31-75	21
08-21-75	48	08-21-75	17	08-20-75	6	08-20-75	13
09-30-75	32	09-29-75	11	08-25-75	5	08-28-75	8
10-20-75	32	10-20-75	12	09-29-75	3	09-29-75	7
11-07-75	30	11-07-75	13	10-20-75	2.3	10-20-75	6
12-08-75	23	12-08-75	10	11-25-75	1.6	11-25-75	7
01-16-76	21	01-16-76	8	12-08-75	1.5	12-08-75	6
02-18-76	18	02-13-76	6	01-16-76	1.3	01-16-76	5
03-10-76	17	03-10-76	6	02-18-76	1.0	02-18-76	4
04-07-76	15	04-07-76	5	03-10-76	1.0	03-10-76	4
04-23-76	20	04-23-76	7	04-07-76	1.0	04-07-76	4
05-05-76	38	05-05-76	13	04-23-76	1.1	04-23-76	5

Table 14 continued ( ). Streamflow at stations on the West Fork Stillwater River, Castle Creek and Picket Pin Creek, 1975-1976.

Castle Creek						Picket Pin Creek	
Station 080		Station 079		Station 077		Station 078	
Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
05-21-76	122	05-21-76	73	05-06-76	2.6	05-06-76	11
06-05-76	130	06-05-76	90	05-21-76	14	05-21-76	46
06-21-76	115	06-21-76	82	06-05-76	20	06-05-76	55
07-05-76	76	07-05-76	48	06-21-76	21	06-21-76	46
				07-05-76	14	07-05-76	31

2. Seasonal movements, and especially spawning movements, of game fishes need investigation. There is some evidence for significant spawning movement of rainbow trout in the Stillwater River.

3. Information on the timing of spawning and early life history stages was developed only for some species in the West Fork Stillwater River drainage. This data should be developed for other streams in the area.

4. Fish population estimates are needed on the Stillwater River downstream from the mouth of the Rosebud River and on the Boulder River downstream from the mouth of the West Boulder River.

5. Metals in fish tissue were not measured for all streams. Remaining streams should be sampled for this purpose before major mining development is announced. Nickel should be remeasured in fish from sections F-1 and F-2 on the Stillwater River.

6. Weekly maximum and minimum stream temperatures should be measured for at least the summer on streams where this has not yet been done.

7. Plans for development by mining companies should be watched closely and appropriate follow-up aquatic studies planned and carried out when and where needed. This should include work to confirm the findings of this study if several years elapse before mining development becomes evident.

8. The identification of remaining streambottom macrofauna samples should be completed. This will supply considerable information for determining impact or lack of it on streams.

RECOMMENDATIONS

1. Two old problems should be remedied. Verdigris Creek carries abnormal concentrations of metals downstream from the gossan. Tailings from the Mouat tailings pond blow into the Stillwater River each winter and early spring. Neither of these situations should be allowed to continue, because there is some indication that one or both problems are causing elevated nickel concentrations in Stillwater River fish.

2. A landslide and water moving through it, one-half mile upstream from the Johns-Manville adit have washed soil into the West Fork Stillwater River in the spring of 1975 and 1976. If this landslide continues each spring, steps should be taken to protect the West Fork Stillwater River.

3. Low summer stream temperatures should not be used as a justification for increasing stream temperature by mining and related development. Downstream areas would be adversely affected.

4. Mining companies should stay informed on state and federal regulations applicable to their operations. This is especially true of water quality regulations.

5. Mills, tailings ponds and smelters should be located on flat land rather than mountainous areas. Potential problems associated with these developments in steep terrain outweigh any advantage gained by placing them close to the mine.

6. A high density of roads has already had detrimental results in the Verdigris and Mountain View drainages. All efforts should be made to limit road building. This is especially true in the Placer Basin-Iron Mountain-Chrome Mountain area at the head of the East Boulder River. Many miles of new road and bulldozer trails have been built in this area in the past several years.

7. Communication and coordination among agencies, companies and the public should be maintained and strengthened. Mining companies should inform appropriate state and federal agencies and the public at the earliest possible date of plans for development before these plans become finalized.

8. Fish are absent from all of Brownlee Creek and from Little Rocky Creek upstream of Forest Service road 1414. These streams may be capable of supporting fish populations. Fingerling cutthroat trout should probably be introduced in these streams.

9. A large spring important to portions of Lodgepole and Castle creeks and the West Fork Stillwater River downstream of Castle Creek is located on private property near the lower end of Lodgepole Creek. The present landowners recognize the importance of this spring, and it receives favorable management, but this might not be the case if the property were sold. If and when the property is for sale, the Department of Fish and Game should consider purchase.

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Waters Referred to:

Stream	Code No.
Blakely Creek	5-22-0658-1
Bobcat (E. Chippy) Cr.	5-22-0728-1
Boulder R. Sec. 01	5-22-0742-1
Boulder R. Sec. 02	5-22-0756-1
Brownlee Creek[a]	-
Castle Creek	5-22-1022-1
Cathedral Creek	5-22-1050-1
Crescent Creek[a]	-
East Boulder River	5-22-2002-1
East Fishtail Creek	5-22-2058-1
East Rosebud River	5-22-2254-1
Falls Creek	5-22-2436-1
Fishtail Creek	5-22-2492-1
Forge Creek	5-22-2598-1
Froze-to-Death Creek	5-22-2681-10
Graham Creek	5-22-2772-1
Great Falls Creek	5-22-2846-10
Hawley Creek	5-22-3010-1
Initial Creek	5-22-3346-1
Iron Creek	5-22-3360-1
Little Rocky Creek	5-22-3752-1
Lodgepole Creek	5-22-3808-1
Lower Deer Creek	5-22-3864-1
Morris Creek	5-22-4275-1
Mountain View Creek	5-22-4280-1
Nye Creek	5-22-4508-1
Picket Pin Creek	5-22-4648-1
Saderbalm Creek	5-22-5166-1
Silver Creek	5-22-5411-1
South Nye Creek[a]	-
Stillwater R. Sec. 01	5-22-6104-1
Stillwater R. Sec. 02	5-22-6118-1
Tumble Creek	5-22-6398-1
Upper Deer Creek	5-22-6454-1
Verdigris Creek[a]	-
W. Boulder River	5-22-6552-1
West Fishtail Creek	5-22-6580-1
W. Fk. Stillwater Sec.01	5-22-6664-1
W. Fk. Stillwater Sec.02	5-22-6678-1
West Fishtail Creek	5-22-6580-1
West Rosebud River	5-22-6804-1
Woodbine Creek	5-22-6944-1

[a]No code number assigned

Appendix A. Location of sampling stations.

Station Number	Stream	T	R	S[a]	Description
001	East Rosebud River	7S	17E	11	Adjacent to Jimmie Joe Campground
002	East Rosebud River	6S	18E	16	At bridge
003	West Rosebud River	6S	17E	28	At Pine Grove Campground
004	West Rosebud River	6S	17E	2	At bridge
005	Stillwater River	5S	15E	32	West channel 200 yards upstream from bridge at Woodbine Campground
006	Stillwater River	5S	15E	15	West channel 1.4 road miles north of the Mouat Mill
007	W. Fork Stillwater River	4S	15E	33	At bridge
008	East Boulder River	3S	13E	29	At Anderson Springs resort
009	East Boulder River	2S	13E	33	At Ewan Campground 200 yards upstream from mouth
010	Boulder River	4S	12E	15	At Falls Creek Campground
011	Boulder River	5S	12E	13	At Flemming Bridge
012	East Fishtail Creek	5S	17E	19	At mouth
013	West Fishtail Creek	5S	17E	19	At mouth
014	Morris Creek	6S	18E	8	200 yards downstream from MacKay Ranch house
015	Little Rocky Creek	5S	16E	21	At road crossing near Little Rocky Campground
016	Nye Creek	5S	15E	15	At road crossing 100 yards upstream from mouth
017	Initial Creek	5S	14E	14	At road crossing
018	Cathedral Creek	5S	14E	14	At road crossing near mouth
019	Iron Creek	5S	14E	12	Near mouth
020	Picket Pin Creek	5S	14E	3	At road crossing
021	Lower Deer Creek	2S	15E	20	At road crossing near National Forest boundary
022	Upper Deer Creek	2S	14E	12	At Rudd Cabin
023	Bobcat (East Chippy) Creek	5S	12E	1	At road crossing near mouth
024	Blakely Creek	4S	12E	25	At road crossing near mouth
025	Graham Creek	4S	12E	23	At road crossing near mouth
026	Great Falls Creek	4S	12E	23	At mouth
027	Falls Creek	4S	12E	15	West channel at road crossing

Appendix A continued ( ). Location of sampling stations.

Station Number	Stream	T	R	S[a]	Description
028	East Rosebud River	5S	18E	34	At Roscoe Bridge
029	West Rosebud River	5S	17E	23	At bridge near mouth
030	Fishtail Creek	5S	17E	19	At bridge near mouth
031	Little Rocky Creek	5S	16E	3	At crossing of Highway 419
032	Stillwater River	4S	16E	31	At USGS station 200 yards below mouth of West Fork
033	Stillwater River	4S	16E	28	At Moraine Fishing Access
034	Stillwater River	4S	17E	18	At Midnight Canyon Bridge
035	Stillwater River	3S	18E	35	At Johnson Bridge
036	West Fork Stillwater	4S	16E	31	At Nye Bridge, south channel
037	West Fork Stillwater	5S	14E	14	At Initial Creek campground
038	East Boulder River	5S	13E	11	0.5 miles upstream from road crossing
039	Boulder River	2S	13E	33	At Ewan Campground 50 yards downstream from bridge
040	Boulder River	2S	13E	1	At bridge
041	West Boulder River	2S	13E	15	At McLeod Bridge
042	Silver Creek	5S	15E	15	At crossing of Highway 419
043	Verdigris Creek	5S	15E	28	At crossing of Highway 419
044	Mountain View Creek	5S	15E	21	At crossing of Highway 419
045	Fishtail Creek	5S	17E	9	At bridge 100 yards upstream from mouth of Sheep Creek
046	East Rosebud River	5S	18E	15	At bridge
047	South Nye Creek	5S	15E	15	At trail crossing 200 yards upstream from mouth
048	Crescent Creek	5S	14E	29	At trail crossing near mouth
049	East Rosebud River	6S	18E	30	1 road mile downstream from TO Bar Ranch buildings
050	Boulder River	4S	12E	25	At Clydehurst Ranch buildings
051	Forge Creek	5S	13E	2	At road crossing near mouth
053	Brownlee Creek	4S	13E	26	At mouth

Appendix A continued ( ). Location of sampling stations.

Station Number	Stream	T	R	S[a]	Description
054	West Fork Stillwater River	5S	14E	30	Near mouth of Lightning Creek
055	Verdigris Creek	5S	15E	20	At wood culvert
058	Woodbine Creek	5S	15E	32	200 yards upstream from mouth
060	Brownlee Creek	4S	13E	27	50 feet below headwater confluence
061	East Boulder River	4S	13E	2	At bridge
070	West Fork Stillwater River	5S	14E	14	0.5 mile upstream from bridge
071	West Fork Stillwater River	5S	14E	14	50 feet above bridge near adit
072	West Fork Stillwater River	5S	14E	14	100 feet downstream from bridge near adit
073	Unnamed tributary to West Fork Stillwater River	5S	14E	14	Adjacent to adit portal
075	Drainage from adit	5S	14E	14	At pipe below adit portal
076	West Fork Stillwater River	4S	15E	26	100 feet upstream from mouth of Horseman Creek
077	Castle Creek	4S	14E	25	At U.S. Forest Service boundary
078	Picket Pin Creek	4S	14E	25	At U.S. Forest Service boundery
079	Castle Creek	4S	15E	29	100 feet upstream from Limestone School bridge
080	Castle Creek	4S	15E	28	1000 feet downstream from mouth of Lodgepole Creek
083	Saderbalm Creek	5S	14E	22	Near mouth
084	Froze-to-death Creek	4S	12E	10	Near mouth
085	Hawley Creek	5S	12E	35	Near mouth

a/ Township, Range, and Section

Appendix B. Summarization of water quality of major streams, 1971 - 1972 - 1973 - 1974[a].

	East Rosebud River Station 001				East Rosebud River Station 002			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Ca[b]	4.10	5.70	2.00	9	5.60	8.60	2.60	9
Mg	1.10	1.50	0.60	9	1.40	1.80	0.70	9
Na	0.90	1.30	0.50	9	1.40	2.40	0.60	9
K	0.80	1.40	0.50	9	0.80	1.70	0.60	9
SiO_2	2.20	3.00	1.00	9	3.50	6.00	1.30	9
HCO_3	17.10	24.00	10.00	9	24.00	36.00	11.00	9
CO_3	0.00	0.00	0.00	9	0.00	0.00	0.00	9
OH	0.00	0.00	0.00	9	0.00	0.00	0.00	9
Cl	0.30	1.00	0.00	9	0.50	1.40	0.10	9
SO_4	3.60	6.00	1.80	9	3.90	5.60	2.60	9
NO_3-N	0.07	0.16	0.00	9	0.09	0.20	0.00	9
F	0.00	0.10	0.00	9	0.00	0.10	0.00	9
pH (lab)	6.74	7.15	6.19	9	6.90	7.18	6.33	9
pH (field)	8.30	8.40	8.20	6	8.20	8.40	8.10	6
F°	43.00	57.00	32.00	8	43.00	60.00	32.00	9
Dis. Sol.	30.50	38.40	18.60	9	41.80	59.60	21.70	9
Hard.	14.00	20.00	9.00	9	20.00	28.00	10.00	9
Alk.	14.00	20.00	8.00	9	20.00	30.00	9.00	9
D.O.	11.20	13.00	8.50	5	11.30	13.00	8.50	6
JTU	1.00	4.00	0.00	4	2.00	3.00	0.00	4
Zn	<0.01	0.01	<0.01	9	<0.01	0.01	<0.01	9
Cd	<0.01	<0.01	<0.01	9	<0.01	<0.01	<0.01	9
Cu	<0.01	<0.01	<0.01	9	<0.01	<0.01	<0.01	9
Ni	<0.02	<0.02	<0.01	9	<0.02	<0.02	<0.02	9
Fe	0.02	0.08	0.00	9	0.12	0.41	<0.02	9
Mn	0.00	0.00	0.00	9	0.00	0.01	0.00	9

SAMPLING DATES (Station 001)	SAMPLING DATES (Station 002)
4-12-71	4-12-71
6-09-71	6-09-71
7-26-71	7-26-71
10-20-71	10-20-71
11-11-71	11-14-71
3-14-72	2-16-72
5-22-72	5-22-72
8-16-72	8-16-72
11-21-72	11-21-72

Appendix B continued ( ). Summarization of water quality of major streams, 1971 - 1972 - 1973 - 1974[a].

	WEST ROSEBUD RIVER STATION 003				WEST ROSEBUD RIVER STATION 004			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Ca[b]	4.30	10.50	2.60	9	5.20	8.60	3.30	9
Mg	0.90	1.30	0.40	9	0.90	1.40	0.60	9
Na	1.00	1.30	0.70	9	1.30	1.90	0.80	9
K	0.80	1.10	0.40	9	0.80	1.20	0.60	9
SiO_2	2.50	4.30	0.00	9	3.60	7.00	1.00	9
HCO_3	17.00	34.00	10.00	9	20.00	27.00	15.00	9
CO_3	0.00	0.00	0.00	9	0.10	1.00	0.00	9
OH	0.00	0.00	0.00	9	0.00	0.00	0.00	9
Cl	0.50	1.40	0.10	9	0.40	1.00	0.10	9
SO_4	3.20	6.20	2.00	9	4.40	7.40	2.20	9
NO_3-N	0.07	0.18	0.00	9	0.04	0.16	0.00	9
F	0.00	0.10	0.00	9	0.00	0.10	0.00	9
pH (lab)	6.70	7.22	6.24	9	6.91	8.42	6.34	9
pH (field)	8.10	8.30	7.90	6	8.20	8.40	7.90	6
F°	43.00	57.00	32.00	8	44.00	60.00	32.00	8
Dis. Sol.	30.30	57.60	19.60	9	36.80	48.50	28.10	9
Hard.	15.00	31.00	10.00	9	17.00	26.00	12.00	9
Alk.	14.00	28.00	8.00	9.	17.00	26.00	12.00	9
D. O.	11.10	12.00	8.60	6	10.90	12.00	8.30	5
JTU	3.00	8.00	0.00	4	2.00	3.00	0.00	4
Zn	<0.01	0.01	<0.01	9	<0.01	0.01	<0.01	9
Cd	<0.01	<0.01	<0.01	9	<0.01	<0.01	<0.01	9
Cu	<0.01	0.01	<0.01	9	<0.01	<0.01	<0.01	9
Ni	<0.02	<0.02	<0.01	9	<0.02	<0.02	<0.02	9
Fe	0.02	0.07	0.02	9	0.03	0.12	0.00	9
Mn	0.00	0.01	0.00	9	0.00	0.01	0.00	9

SAMPLING DATES (003)	SAMPLING DATES (004)
04-12-71	04-12-71
06-09-71	06-09-71
07-26-71	07-26-71
10-20-71	10-20-71
11-11-71	11-11-71
02-10-72	02-10-72
05-22-72	05-22-72
08-09-72	08-09-72
12-01-72	11-21-72

Appendix B continued ( ). Summarization of water quality of major streams, 1971 - 1972 - 1973 - 1974[a].

	STILLWATER RIVER STATION 005				STILLWATER RIVER STATION 006			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Ca[b]	4.90	7.10	2.60	16	8.40	16.40	3.60	16
Mg	1.10	1.80	0.60	16	2.00	3.10	0.70	16
Na	1.40	2.50	0.60	16	1.60	2.70	0.60	16
K	0.70	1.60	0.40	16	0.80	1.50	0.40	16
SiO_2	4.60	7.30	1.30	16	5.00	9.00	1.30	16
HCO_3	19.00	26.00	13.00	16	28.00	51.00	13.00	16
CO_3	0.00	0.00	0.00	16	0.00	0.00	0.00	16
OH	0.00	0.00	0.00	16	0.00	0.00	0.00	16
Cl	0.50	1.50	0.20	16	0.50	1.40	0.00	16
SO_4	4.50	7.40	2.00	16	8.30	14.00	2.80	16
NO_3-N	0.07	0.23	0.00	16	0.07	0.23	0.00	16
F	0.00	0.10	0.00	16	0.00	0.10	0.00	16
pH (lab)	6.81	7.24	6.32	16	6.88	8.12	6.04	16
pH (field)	8.30	8.40	7.80	13	8.20	8.50	7.00	13
F°	41.00	55.00	32.00	15	43.00	56.00	32.00	15
Dis. Sol.	37.00	48.60	23.40	16	54.30	92.00	26.80	16
Hard.	17.00	21.00	11.00	16	28.00	51.00	12.00	16
Alk	15.00	22.00	10.00	16	23.00	42.00	10.00	16
D. O.	11.40	16.00	9.50	12	10.90	13.40	9.40	13
JTU	2.00	10.00	0.00	9	2.00	8.00	0.00	9
Zn	<0.01	0.01	<0.01	16	<0.01	0.02	<0.01	16
Cd	<0.01	<0.01	<0.01	16	<0.01	<0.01	<0.01	16
Cu	<0.01	0.01	<0.01	16	<0.01	0.02	<0.01	16
Ni	<0.02	<0.02	<0.02	16	<0.02	<0.02	<0.02	16
Fe	0.06	0.20	0.00	16	0.06	0.24	0.00	16
Mn	0.00	0.01	0.00	16	0.00	0.01	0.00	16

SAMPLING DATES (Station 005)	SAMPLING DATES (Station 006)
04-12-71	04-12-71
06-09-71	06-09-71
07-26-71	07-26-71
10-19-71	10-19-71
11-11-71	11-11-71
12-18-71	12-18-71
01-17-72	01-22-72
02-14-72	02-14-72
03-14-72	03-14-72
04-19-72	04-29-72
05-16-72	05-16-72
06-21-72	06-21-72
07-14-72	07-14-72
08-03-72	08-03-72
09-18-72	09-18-72
12-01-72	12-01-72

Appendix B continued ( ). Summarization of water quality of major streams, 1971 - 1972 - 1973 - 1974[a].

	WEST FORK STILLWATER RIVER STATION 007				WEST FORK STILLWATER RIVER STATION 054			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Ca[b]	13.00	21.00	5.00	16	6.50	7.90	3.40	8
Mg	4.00	6.70	0.50	16	2.30	3.80	0.40	8
Na	1.60	2.40	0.80	16	1.20	1.50	0.90	8
K	0.90	1.80	0.50	16	0.80	1.00	0.50	8
SiO_2	6.80	10.00	2.00	16	5.50	7.00	3.00	8
HCO_3	57.00	94.00	22.00	16	26.00	33.00	13.00	8
CO_3	0.00	1.00	0.00	16	0.00	0.00	0.00	8
OH	0.00	0.00	0.00	16	0.00	0.00	0.00	8
Cl	0.40	1.10	0.20	16	0.60	2.00	0.20	8
SO_4	5.90	8.60	2.20	16	6.10	11.40	2.80	8
NO_3-N	0.04	0.23	0.00	16	0.07	0.16	0.00	8
F	0.00	0.10	0.00	16	0.00	0.00	0.00	8
pH (lab)	7.29	8.32	6.38	16	7.28	7.74	6.73	8
pH (field)	8.30	8.60	6.90	13	8.20	8.60	7.40	8
F^o	42.00	53.00	32.00	15	40.00	47.00	33.00	8
Dis. Sol.	90.10	133.10	40.00	16	49.20	54.60	27.00	8
Hard.	48.00	76.00	21.00	16	25.00	35.00	16.00	8
Alk.	47.00	76.00	21.00	16	21.00	27.00	11.00	8
D. O.	10.80	12.80	9.00	12	10.10	10.90	9.20	8
JTU	0.00	2.00	0.00	10	0.00	2.00	0.00	8
Zn	<0.01	0.02	<0.01	16	<0.01	0.02	<0.01	7
Cd	<0.01	<0.01	<0.01	16	<0.01	<0.01	<0.01	7
Cu	<0.01	0.02	<0.01	16	<0.01	<0.02	<0.01	7
Ni	<0.02	<0.02	<0.02	16	<0.01	<0.05	<0.01	7
Fe	0.10	0.92	0.00	16	0.02	0.10	0.00	8
Mn	0.00	0.01	0.00	16	0.00	0.00	0.00	8

SAMPLING DATES

04-13-71
06-09-71
07-26-71
10-19-71
11-11-71
12-18-71
01-17-72
02-16-72
03-14-72
04-19-72
05-16-72
06-21-72
07-14-72
08-07-72
09-18-72
12-01-72

SAMPLING DATES

05-30-73
07-24-73
09-24-73
10-24-73
05-13-74
07-23-74
09-19-74
10-11-74

Appendix B continued ( ). Summarization of water quality of major streams, 1971 - 1972 - 1973 - 1974[a].

EAST BOULDER RIVER STATION 038	Mean	Max.	Min.	No. of Samples	EAST BOULDER RIVER STATION 008 Mean	Max.	Min.	No. of Samples
Ca[b]	3.40	6.30	2.00	7	23.80	32.00	10.40	16
Mg	1.40	1.70	1.00	7	5.70	6.90	2.00	16
Na	1.50	1.60	1.20	7	1.40	2.00	0.80	16
K	0.60	0.60	0.50	7	0.50	1.00	0.20	16
SiO_2	7.40	9.60	3.80	7	6.70	10.00	2.60	16
HCO_3	16.00	24.00	12.00	7	89.00	122.00	36.00	16
CO_3	0.00	0.00	0.00	7	0.00	2.00	0.00	16
OH	0.00	0.00	0.00	7	0.00	0.00	0.00	16
Cl	0.70	1.30	0.30	7	0.30	1.00	0.00	16
SO_4	2.70	5.60	0.30	7	7.00	12.20	1.80	16
NO_3-N	0.07	0.18	0.02	7	0.02	0.18	0.00	16
F	0.00	0.00	0.00	6	0.00	0.10	0.00	16
pH (lab)	7.46	8.53	7.12	7	7.65	8.41	6.82	16
pH (field)	8.10	8.60	7.40	6	8.50	8.60	8.00	13
F°	52.00	61.00	42.00	7	40.00	52.00	32.00	16
Dis. Sol.	33.80	43.60	29.60	7	142.00	180.10	63.00	16
Hard.	14.00	21.00	10.00	7	82.00	105.00	35.00	16
Alk.	13.00	21.00	10.00	7	78.00	104.00	29.00	16
D. O.	8.50	9.40	7.30	6	11.00	12.10	9.20	12
JTU	1.00	5.00	0.00	6	1.00	5.00	0.00	10
Zn	<0.01	0.01	<0.01	5	<0.01	0.01	<0.01	16
Cd	<0.01	<0.01	<0.01	5	<0.01	<0.01	<0.01	16
Cu	<0.01	<0.01	<0.01	5	<0.01	<0.01	<0.01	16
Ni	<0.01	<0.05	<0.01	5	<0.02	<0.02	<0.02	16
Fe	0.02	0.10	0.00	7	0.02	0.17	0.00	16
Mn	0.00	0.01	0.00	7	0.00	0.01	0.00	16

SAMPLING DATES (Station 038)	SAMPLING DATES (Station 008)
07-28-71	04-15-71
07-25-73	06-10-71
09-20-73	07-27-71
10-23-73	10-26-71
07-25-74	11-14-71
09-18-74	12-17-71
10-10-74	01-17-72
	02-17-72
	03-24-72
	04-19-72
	05-17-72
	06-22-72
	07-19-72
	08-14-72
	09-19-72
	11-30-72

Appendix B continued ( ). Summarization of water quality of major streams, 1971 - 1972 - 1973 - 1974[a].

	EAST BOULDER RIVER STATION 009				BOULDER RIVER STATION 010			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Ca[b]	41.60	55.00	17.90	16	9.00	13.20	4.80	16
Mg	9.60	15.30	3.20	16	2.20	3.50	0.80	16
Na	4.80	12.70	1.60	16	2.00	2.80	1.00	16
K	1.20	2.50	0.50	16	1.20	2.10	0.60	16
SiO_2	7.10	11.00	3.20	16	7.70	11.00	3.00	16
HCO_3	141.00	178.00	59.00	16	37.00	54.00	23.00	16
CO_3	0.00	5.00	0.00	16	0.00	1.00	0.00	16
OH	0.00	0.00	0.00	16	0.00	0.00	0.00	16
Cl	1.40	3.30	0.30	16	0.50	1.50	0.10	16
SO_4	44.00	63.00	9.40	16	6.50	11.40	2.60	16
NO_3-N	0.07	0.23	0.00	16	0.04	0.18	0.00	16
F	0.00	0.20	0.00	16	0.02	0.13	0.00	16
pH (lab)	7.92	8.48	7.00	16	7.06	8.34	6.53	16
pH (field)	8.40	8.70	7.60	13	8.40	8.70	8.30	13
F°	42.00	58.00	33.00	16	40.00	54.00	32.00	16
Dis. Sol	253.20	324.90	97.70	16	69.90	89.90	40.60	16
Hard.	150.00	196.00	57.00	16	31.00	46.00	20.00	16
Alk.	116.00	158.00	48.00	15	30.00	44.00	19.00	16
D. O.	11.10	12.40	9.30	12	11.10	12.00	8.90	13
JTU	4.00	20.00	0.00	10	3.00	8.00	0.00	9
Zn	<0.01	0.015	<0.01	16	<0.01	0.01	<0.01	16
Cd	<0.01	<0.01	<0.01	16	<0.01	<0.01	<0.01	16
Cu	<0.01	<0.01	<0.01	16	<0.01	<0.01	<0.01	16
Ni	<0.02	<0.02	<0.02	16	<0.02	<0.02	<0.02	16
Fe	0.11	0.55	0.00	16	0.10	0.68	0.00	16
Mn	0.00	0.02	0.00	16	0.00	0.03	0.00	16

SAMPLING DATES	SAMPLING DATES
04-15-71	04-15-71
06-10-71	06-10-71
07-27-71	07-27-71
10-26-71	10-26-71
11-14-71	11-14-71
12-17-71	12-17-71
01-17-72	01-22-72
02-17-72	02-17-72
03-24-72	03-24-72
04-29-72	04-19-72
05-18-72	05-17-72
06-22-72	06-22-72
07-19-72	07-19-72
08-17-72	08-17-72
09-19-72	09-19-72
11-30-72	11-30-72

Appendix B continued ( ). Summarization of water quality of major streams, 1971 - 1972 - 1973 - 1974[a].

BOULDER RIVER STATION 011	Mean	Max.	Min.	No. of Samples	SAMPLING DATES
Ca[b]	8.70	14.20	4.80	11	
Mg	2.20	2.80	1.40	11	10-26-71
Na	2.00	2.80	1.00	11	11-14-71
K	1.00	1.50	0.60	11	12-17-71
SiO_2	9.00	11.00	3.20	11	03-24-72
HCO_3	36.00	47.00	24.00	11	04-19-72
CO_3	0.00	0.00	0.00	11	05-17-72
OH	0.00	0.00	0.00	11	06-22-72
Cl	0.40	0.60	0.10	11	07-19-72
SO_4	5.80	10.40	2.60	11	08-15-72
NO_3-N	0.07	0.16	0.00	11	09-19-72
F	0.01	0.12	0.00	11	11-27-72
pH (lab)	7.17	7.94	6.46	11	
pH (field)	8.40	8.70	8.20	11	
F°	41.00	52.00	31.00	10	
Dis. Sol.	65.30	86.00	44.80	11	
Hard.	31.00	44.00	20.00	11	
Alk.	30.00	39.00	20.00	11	
D. O.	10.70	12.00	9.10	11	
JTU	1.00	7.00	0.00	8	
Zn	<0.01	0.01	<0.01	11	
Cd	<0.01	<0.01	<0.01	11	
Cu	<0.01	<0.01	<0.01	11	
Ni	<0.02	<0.02	<0.02	11	
Fe	0.07	0.27	0.00	11	
Mn	0.00	0.01	0.00	11	

a/ Units are milligrams per liter except as indicated.

b/ Standard chemical abbreviations, and as follows:

F° = Temperature, field
Dis. Sol. = Calculated dissolved solids
Hard. = Total hardness as $CaCO_3$
Alk. = Total alkalinity as $CaCO_3$
D. O. = Dissolved oxygen, field
JTU = Turbidity, field

Appendix C. Summarization of water quality data for stations on Rosebud tributaries, 1972[a].

	EAST FISHTAIL CREEK STATION 012[b]		WEST FISHTAIL CREEK STATION 013[c]			MORRIS CREEK STATION 014[c]		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Ca	10.80	10.20	5.10	8.70	3.00	16.50	20.00	10.80
Mg	3.80	3.80	1.10	1.60	0.60	3.60	4.90	2.20
Na	3.70	2.50	1.90	2.50	1.00	12.00	17.00	7.00
K	0.71	0.61	0.69	0.90	0.60	1.00	1.40	0.70
SiO_2	11.40	8.70	7.90	11.50	5.00	16.00	18.00	14.00
HCO_3	55.00	52.00	22.00	32.00	15.00	92.00	115.00	66.00
CO_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl	0.50	0.40	0.30	0.60	0.10	0.80	1.30	0.30
SO_4	6.00	4.20	4.40	5.60	2.60	6.60	9.60	2.00
NO_3-N	0.16	0.00	0.09	0.18	0.00	0.09	0.23	0.04
F	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.00
pH (lab)	6.75	6.65	6.64	7.18	6.40	7.08	7.11	6.90
pH (field)	8.50	8.40	8.30	8.50	8.10	8.40	8.40	8.30
FO	41.00	32.00	40.00	52.00	32.00	45.00	70.00	32.00
Dis. Sol.	89.20	86.00	43.90	61.70	28.30	150.40	187.40	105.80
Hard.	43.00	41.00	17.00	25.00	10.00	56.00	70.00	39.00
Alk.	45.00	43.00	18.00	27.00	12.00	75.00	94.00	54.00
D. O.	11.50	10.40	10.70	11.60	9.60	10.70	12.10	7.10
JTU	12.00	5.00	1.00	5.00	0.00	18.00	35.00	8.00
Zn	0.01	<0.01	<0.01	0.015	<0.01	<0.01	0.01	<0.01
Cd	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fe	0.21	0.06	0.02	0.05	0.00	0.71	1.10	0.46
Mn	0.00	0.00	0.00	0.00	0.00	0.10	0.36	0.00

Appendix C continued ( ). Summarization of water quality data for stations on Rosebud tributaries, 1972[a].

EAST FISHTAIL CREEK STATION 012[b]		WEST FISHTAIL CREEK STATION 013[c]			MORRIS CREEK STATION 014[c]		
Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
SAMPLING DATES		SAMPLING DATES			SAMPLING DATES		
05-25-72		02-14-72			02-10-72		
11-22-72		05-25-72			05-22-72		
		08-09-72			08-16-72		
		11-22-72			11-21-72		

a/ Units are milligrams per liter except as indicated.

b/ Two samples.

c/ Four samples.

Appendix D. Summarization of water quality data for stations on Stillwater River tributaries, 1972 - 1973[a].

	LITTLE ROCKY CREEK STATION 015[b]			NYE CREEK STATION 016[b]		
	Mean	Max.	Min.	Mean.	Max.	Min.
Ca	14.30	18.20	11.20	9.40	10.40	8.70
Mg	4.50	5.60	3.70	7.60	7.70	7.50
Na	1.90	2.40	1.50	2.00	2.20	1.80
K	0.50	0.60	0.38	0.45	0.60	0.31
SiO_2	10.50	12.80	8.70	17.00	18.00	16.00
HCO_3	67.00	80.00	54.00	67.00	69.00	64.00
CO_3	0.00	0.00	0.00	0.00	0.00	0.00
OH	0.00	0.00	0.00	0.00	0.00	0.00
Cl	0.20	0.40	0.00	0.10	0.10	0.10
SO_4	4.80	7.90	2.00	6.90	7.90	6.40
NO_3-N	0.09	0.16	0.00	0.16	0.23	0.00
F	0.00	0.00	0.00	0.00	0.00	0.00
pH (lab)	6.73	6.77	6.69	6.97	7.16	6.78
pH (field)	8.30	8.50	8.10	8.50	8.50	8.40
F°	41.00	54.00	32.00	42.00	51.00	32.00
Dis. Sol.	103.90	128.60	86.30	111.20	115.10	105.10
Hard.	55.00	68.00	44.00	56.00	57.00	53.00
Alk.	55.00	66.00	44.00	55.00	57.00	52.00
D. O.	10.60	12.90	8.20	10.40	12.10	9.20
JTU	2.00	7.00	0.00	2.00	5.00	0.00
Zn	0.01	0.01	<0.01	<0.01	0.01	<0.01
Cd	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fe	0.05	0.11	0.00	0.21	0.53	0.00
Mn	0.00	0.01	0.00	0.00	0.01	0.00

SAMPLING DATES	SAMPLING DATES
05-25-72	05-24-72
08-07-72	08-10-72
11-22-72	11-24-72

a/ Units are milligrams per liter except as indicated.

b/ Three samples except for lab pH which is two.

Appendix D continued ( ). Summarization of water quality data for stations on Stillwater River tributaries, 1972 - 1973.

	SILVER CREEK STATION 042[c]		MOUNTAIN VIEW CREEK STATION 044[d]		SOUTH NYE CREEK STATION 047[c]	
	Max.	Min.	Max.	Min.	Max.	Min.
Ca	50.00	49.00	17.40	15.00	17.90	8.80
Mg	18.00	17.80	17.90	12.20	9.80	6.80
Na	2.30	1.90	4.00	2.90	3.50	1.80
K	0.70	0.59	0.70	0.70	0.52	0.46
SiO_2	12.80	8.60	17.10	16.00	18.50	16.00
HCO_3	147.00	143.00	136.00	102.00	101.00	58.00
CO_3	0.00	0.00	0.00	0.00	0.00	0.00
OH	0.00	0.00	0.00	0.00	0.00	0.00
Cl	0.40	0.10	2.00	0.00	0.80	0.50
SO_4	74.00	74.00	11.00	7.20	9.00	4.80
NO_3-N	0.20	0.04	0.5	0.07	0.18	0.00
F	0.20	0.00	0.00	0.00	0.00	0.00
pH (lab)	8.42	7.28	7.00	--	7.64	7.26
pH (field)	8.60	8.60	8.50	8.50	8.40	8.40
Fo	60.00	50.00	52.00	36.00	49.00	37.00
Dis. Sol.	304.50	300.60	208.80	157.00	163.10	97.80
Hard.	199.00	195.00	118.00	88.00	85.00	50.00
Alk.	126.00	121.00	112.00	84.00	83.00	48.00
D. O.	9.60	8.60	11.20	9.00	10.80	9.70
JTU	0.00	0.00	10.00	0.00	12.00	5.00
Zn	0.01	0.01	0.01	0.01	0.01	0.01
Cd	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cu	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ni	< 0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02
Fe	0.04	0.03	0.21	0.16	1.28	0.08
Mn	0.01	0.00	0.00	0.00	0.03	0.00

SAMPLING DATES	SAMPLING DATES	SAMPLING DATES
06-21-72	06-21-72	06-21-72
11-24-72	11-24-72	11-24-72

c/ Two samples.

d/ Two samples except for lab pH which is one.

Appendix D continued ( ). Summarization of water quality data for station on Stillwater River tributaries, 1972 - 1973.[a]

	VERDIGRIS CREEK STATION 043[e]			VERDIGRIS CREEK STATION 055[f]			WOODBINE CREEK STATION 058[g]	
	Mean	Max.	Min.	Mean	Max.	Min.	Max.	Min.
Ca	7.90	11.30	3.40	4.50	6.60	2.30	3.1	2.60
Mg	10.90	16.00	4.30	4.50	5.60	2.70	1.10	0.50
Na	2.30	3.00	1.50	1.80	2.00	1.40	1.20	1.00
K	0.75	1.10	0.50	0.60	0.70	0.40	0.60	0.51
SiO_2	13.80	16.00	11.00	11.20	13.50	9.80	6.00	-
HCO_3	38.00	48.00	21.00	35.00	42.00	25.00	11.00	11.00
CO_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl	1.10	3.30	0.10	0.20	0.40	0.00	0.20	0.10
SO_4	36.70	61.00	7.20	3.40	4.40	2.40	3.00	2.90
NO_3-N	0.11	0.23	0.00	0.23	0.54	0.00	0.07	0.02
F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pH (lab)	7.24	7.97	6.61	7.52	7.83	6.78	6.89	6.65
pH (field)	8.20	8.50	7.70	8.10	8.50	7.50	8.40	7.50
F^o	48.00	59.00	32.00	41.00	47.00	37.00	43.00	42.00
Dis. Sol.	112.80	149.80	49.60	60.00	76.20	45.50	26.10	19.90
Hard.	65.00	93.00	26.00	30.00	37.00	20.00	11.00	10.00
Alk.	31.00	39.00	18.00	29.00	34.00	20.00	9.00	9.00
D. O.	9.60	10.70	8.50	9.80	10.40	8.90	10.60	10.40
JTU	4.00	10.00	0.00	0.00	0.00	0.00	8.00	0.00
Zn	< 0.01	0.015	< 0.01	< 0.01	0.01	< 0.01	< 0.01	-
Cd	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-
Cu	0.10	0.14	0.05	< 0.02	< 0.02	< 0.02	< 0.02	-
Ni	0.40	0.59	0.09	< 0.05	< 0.05	< 0.05	< 0.05	-
Fe	0.30	0.58	0.17	0.05	0.10	0.00	0.05	0.00
Mn	0.04	0.06	0.01	0.00	0.00	0.00	0.00	0.00

Appendix D continued ( ). Summarization of water quality data for station on Stillwater River tributaries, 1972 - 1973.

VERDIGRIS CREEK STATION 043[e]				VERDIGRIS CREEK STATION 055[f]			WOODBINE CREEK STATION 058[g]	
	Mean	Max.	Min.	Mean	Max.	Min.	Max.	Min.
SAMPLING DATES				SAMPLING DATES			SAMPLING DATES	
06-21-72				06-04-73			06-04-73	
09-18-72				07-26-73			09-25-73	
11-24-72				09-25-73				
06-04-73				10-25-73				
07-26-73								
09-25-73								
10-25-73								

e/ Seven samples except six for cadmium, nickel, copper and zinc.

f/ Four samples except three for cadmium, nickel, copper, zinc and temperature.

g/ Two samples except one for silica, cadmium, nickel, copper and zinc.

Appendix E. Summarization of water quality data for stations on the West Fork Stillwater River, 1975 and 1976[a].

	STATION 076			STATION 037		
	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples
Ca	39.35	14.80	7	10.61	3.50	10
Mg	14.27	4.70	7	5.59	1.60	10
Na	4.00	1.80	7	2.00	0.90	10
K	1.20	0.60	7	1.20	0.60	10
SiO_2	10.30	6.00	7	8.80	4.70	10
HCO_3	149.08	59.00	7	51.00	17.00	10
CO_3	0.00	0.00	7	0.00	0.00	10
Cl	2.50	0.30	7	1.70	0.10	10
SO_4	31.44	9.70	7	7.30	3.50	10
NO_3-N	0.27	0.04	7	0.17	0.00	11
NO_2-N	<0.01	-	1	<0.01	< 0.01	3
NH_3-N	0.04	-	1	0.04	< 0.03	2
F	0.10	0.00	7	<0.10	0.00	10
pH (lab)	8.29	6.26	7	7.79	5.80	10
pH (field)	8.60	8.00	7	8.70	7.70	18[b]
F°	50.00	36.00	7	46.00	34.00	10
Dis. Sol.	248.70	97.00	7	86.50	33.00	10
Hard.	157.00	56.00	7	48.00	16.00	10
Alk.	146.00	48.00	7	42.00	14.00	10
D. O.	11.50	9.60	7	11.30	9.70	8
JTU	48.00	2.00	7	12.00	0.00	16[b]
T. Susp. Sol.[c]	122.76	0.61	7	7.21	< 0.10	18[b]
V. Susp. Sol.[d]	10.93	0.50	7	1.20	< 0.10	18[b]
Zn-Total	<0.01	<0.01	7	< 0.01	< 0.01	10
Zn-Dissolved	<0.01	<0.01	7	< 0.01	< 0.01	10
Cd-Total	<0.01	<0.01	7	< 0.01	< 0.01	10
Cd-Dissolved	<0.01	<0.01	7	< 0.01	< 0.01	10
Cu-Total	0.01	<0.01	7	< 0.01	< 0.01	10
Cu-Dissolved	<0.01	<0.01	7	< 0.01	< 0.01	10
Ni-Total	0.03	<0.01	7	< 0.01	< 0.01	10
Ni-Dissolved	<0.01	<0.01	7	< 0.01	< 0.01	10
Fe-Dissolved	0.23	<0.01	7	0.12	0.00	10
Mn-Dissolved	<0.01	<0.01	7	< 0.01	0.00	10
Al-Total	2.43	0.05	7	0.68	< 0.05	10
Al-Dissolved	0.14	<0.05	7	0.19	< 0.05	10

SAMPLING DATES (Station 076)	SAMPLING DATES (Station 037)
06-20-75	03-17-75
07-23-75	05-13-75
08-12-75	06-21-75
09-09-75	07-24-75
10-07-75	08-12-75
12-05-75	09-11-75
03-09-76	10-06-75
	12-04-75
	01-12-76 (NO_3 and NO_2 only)
	02-09-76
	03-08-76

a/ Units are milligrams per liter except as indicated.

b/ Sampling period 1-75 to 3-76.

c/ T. Susp. Sol. = Total Suspended solids.

d/ V. Susp. Sol. = Volatile suspended solids.

Appendix E continued ( ). Summarization of water quality data for stations on the West Fork Stillwater River, 1975 and 1976[a].

	STATION 072			STATION 070		
	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples
Ca	9.70	3.60	9	10.33	3.40	11
Mg	4.90	1.60	9	4.76	1.40	11
Na	2.00	0.90	9	2.30	0.90	11
K	1.20	0.60	9	1.20	0.60	11
SiO_2	7.80	4.10	9	8.60	4.30	11
HCO_3	45.00	23.00	9	45.75	10.00	11
CO_3	0.00	0.00	9	0.00	0.00	11
Cl	1.80	0.00	9	1.90	1.30	11
SO_4	9.50	3.40	9	8.90	3.60	11
NO_3-N	0.27	0.04	9	0.16	0.00	12
NO_2-N	-	-	0	< 0.01	< 0.01	3
NH_3-N	-	-	0	0.03	< 0.03	2
F	0.10	0.00	9	0.10	< 0.10	11
pH (lab)	7.62	5.86	9	7.82	5.93	11
pH (field)	8.50	7.80	16[e]	8.60	7.60	18[b]
F°	47.00	33.00	9	47.00	33.00	11
Dis. Sol.	78.60	37.70	9	80.50	24.70	11
Hard.	44.00	15.00	9	44.00	14.00	11
Alk.	37.00	19.00	9	38.00	8.00	11
D. O.	11.20	9.40	6	11.20	9.30	7
JTU	8.00	0.00	14[e]	5.00	0.00	16[b]
T. Susp. Sol.	40.62	0.10	16[e]	4.99	< 0.10	17[b]
V. Susp. Sol.	3.91	0.00	16[e]	1.00	< 0.10	17[b]
Zn-Total	< 0.01	< 0.01	9	0.01	< 0.01	10
Zn-Dissolved	< 0.01	< 0.01	9	< 0.01	< 0.01	11
Cd-Total	< 0.01	< 0.01	9	< 0.01	< 0.01	10
Cd-Dissolved	< 0.01	< 0.01	9	< 0.01	< 0.01	11
Cu-Total	< 0.01	< 0.01	9	< 0.01	< 0.01	10
Cu-Dissolved	< 0.01	< 0.01	9	< 0.01	< 0.01	11
Ni-Total	< 0.01	< 0.01	9	< 0.01	< 0.01	10
Ni-Dissolved	< 0.01	< 0.01	9	< 0.01	< 0.01	11
Fe-Dissolved	0.07	0.00	9	0.05	0.00	10
Mn-Dissolved	< 0.01	0.00	9	< 0.01	0.00	11
Al-Total	0.30	< 0.05	7	0.20	< 0.05	9
Al-Dissolved	0.14	< 0.05	7	0.12	< 0.05	9

SAMPLING DATES (Station 072)	SAMPLING DATES (Station 070)
01-07-75	01-07-75
03-03-75	03-03-75
05-13-75	05-13-75
06-21-75	06-21-75
07-24-75	07-24-75
08-12-75	08-12-75
09-11-75	09-11-75
10-06-75	10-06-75
12-04-75	12-04-75
	01-12-76 (NO_2, NO_3 only)
	02-09-76
	03-08-76

e/ Sampling period 1-75 to 12-75.

Appendix F. Summarization of water quality data for stations on West Fork Stillwater River tributaries, 1972 - 1973 - 1974[a].

	INITIAL CREEK[b] STATION 017		CATHEDRAL CREEK[b] STATION 018		IRON CREEK STATION 019			
	Max.	Min.	Max.	Min.	Mean	Max.	Min.	No. of Samples
Ca	34.00	23.00	4.10	3.50	15.70	21.00	10.70	6
Mg	11.30	8.20	2.90	2.80	4.10	5.30	2.90	6
Na	2.10	1.40	2.10	1.60	1.40	1.80	0.80	6
K	0.41	0.33	0.48	0.33	0.36	0.78	0.20	6
SiO_2	11.40	10.00	10.00	8.60	9.70	10.00	8.70	6
HCO_3	154.00	112.00	28.00	27.00	55.00	87.00	48.00	6
CO_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
OH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
Cl	0.20	0.20	0.30	0.30	0.50	0.90	0.30	6
SO_4	7.80	1.60	3.90	2.40	4.20	5.40	2.60	6
NO_3-N	0.02	0.00	0.04	0.00	0.02	0.07	0.00	6
F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
pH (lab)	7.46	-	6.45	-	7.46	7.93	6.55	5
pH (field)	8.60	8.60	8.30	8.30	8.20	8.60	7.60	6
F°	36.00	32.00	36.00	32.00	41.00	53.00	36.00	6
Dis. Sol.	220.40	156.50	50.40	48.20	101.10	131.10	74.60	6
Hard.	130.00	90.00	22.00	20.00	56.00	70.00	39.00	6
Alk.	126.00	92.00	23.00	22.00	53.00	72.00	36.00	6
D. O.	10.80	9.70	10.80	8.70	9.30	10.80	5.00	6
JTU	4.00	0.00	2.00	0.00	1.00	7.00	0.00	6
Zn	0.01	< 0.01	0.01	< 0.01	< 0.01	0.01	< 0.01	6
Cd	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	6
Cu	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	6
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	< 0.02	< 0.01	6
Fe	0.06	0.02	0.06	0.00	0.02	0.06	0.00	6
Mn	0.01	0.01	0.01	0.00	0.01	0.01	0.00	6

Appendix F continued ( ). Summarization of water quality data for stations on West Fork Stillwater River tributaries, 1972 - 1973 - 1974[a].

INITIAL CREEK[b] STATION 017			CATHEDRAL CREEK[b] STATION 018		IRON CREEK STATION 019			
	Max.	Min.	Max.	Min.	Mean	Max.	Min.	No. of Samples
SAMPLING DATES			SAMPLING DATES		SAMPLING DATES			
05-24-72			05-24-72		05-24-72			
11-22-72			11-22-72		11-22-72			
					05-14-74			
					07-23-74			
					09-19-74			
					10-11-74			

a/ Units are milligrams per liter except as indicated.

b/ 2 samples per station except for lab pH which is 1.

Appendix F continued ( ). Summarization of water quality data for stations on West Fork Stillwater River tributaries, 1972 - 1973 - 1974[a].

	PICKET PIN CREEK STATION 020				CRESCENT CREEK STATION 048			
	Mean	Max.	Min.	No. of Samples	Mean.	Max.	Min.	No. of Samples
Ca	14.30	16.20	10.70	6	6.00	6.60	5.10	4
Mg	2.20	3.30	1.20	6	8.40	9.60	6.70	4
Na	1.50	1.70	1.30	6	0.70	1.00	0.50	4
K	0.19	0.20	0.16	6	0.40	0.50	0.29	4
SiO_2	8.80	9.30	8.20	6	14.00	15.00	13.00	4
HCO_3	51.00	57.00	40.00	6	53.00	59.00	45.00	4
CO_3	0.00	0.00	0.00	6	0.00	0.00	0.00	4
OH	0.00	0.00	0.00	6	0.00	0.00	0.00	4
Cl	0.50	0.90	0.20	6	0.50	0.70	0.20	4
SO_4	4.00	6.40	2.00	6	6.20	7.30	3.80	4
NO_3-N	0.02	0.07	0.00	6	0.04	0.07	0.00	4
F	0.00	0.00	0.00	6	0.00	0.00	0.00	4
pH (lab)	7.28	7.71	6.50	5	7.01	7.21	6.87	4
pH (field)	8.40	8.60	7.90	6	8.10	8.50	7.00	4
F^o	40.00	46.00	32.00	6	45.00	54.00	33.00	4
Dis. Sol.	82.90	94.60	64.60	6	89.20	98.50	80.90	4
Hard.	44.00	52.00	32.00	6	49.00	54.00	44.00	4
Alk.	42.00	48.00	33.00	6	43.00	48.00	37.00	4
D. O.	9.60	10.30	8.60	6	8.70	10.40	6.00	4
JTU	1.00	7.00	0.00	6	3.00	6.00	0.00	4
Zn	< 0.01	0.015	< 0.01	6	< 0.01	0.03	< 0.01	3
Cd	< 0.01	< 0.01	< 0.01	6	< 0.01	< 0.01	< 0.01	3
Cu	< 0.01	< 0.01	< 0.01	6	< 0.01	0.01	< 0.01	3
Ni	< 0.01	< 0.02	< 0.01	6	< 0.01	0.02	< 0.01	3
Fe	0.02	0.05	0.00	6	0.19	0.55	0.00	4
Mn	0.00	0.02	0.00	6	0.01	0.03	0.00	4

Appendix F continued ( ). Summarization of water quality data for stations on West Fork Stillwater River tributaries, 1972 - 1973 - 1974[a].

PICKET PIN CREEK STATION 020	Mean	Max.	Min.	No. of Samples	CRESCENT CREEK STATION 048	Mean	Max.	Min.	No. of Samples
SAMPLING DATES					SAMPLING DATES				
05-25-72					09-12-72				
12-01-72					05-30-73				
05-14-74					05-13-74				
07-24-74					07-23-74				
09-19-74									
10-10-74									

Appendix G. Summarization of water quality data for stations on West Fork Stillwater River tributaries, 1975 and 1976[a].

	CASTLE CREEK STATION 080			CASTLE CREEK STATION 079			CASTLE CREEK STATION 077		
	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples
Ca	52.89	32.00	7	48.94	26.00	7	50.46	36.00	7
Mg	17.73	8.00	7	16.71	5.60	7	20.74	8.40	7
Na	4.00	2.30	7	3.20	1.40	7	1.50	0.90	7
K	1.20	0.80	7	1.20	0.70	7	1.00	0.80	7
SiO_2	11.20	7.60	7	8.60	6.70	7	7.30	4.70	7
HCO_3	208.00	154.00	7	208.00	96.00	7	206.79	144.00	7
CO_3	3.00	0.00	7	0.00	0.00	7	0.00	0.00	7
Cl	1.40	0.00	6	2.35	0.20	7	1.60	0.00	7
SO_4	46.39	26.00	7	28.61	8.20	7	34.80	11.40	7
NO_3-N	0.43	0.16	7	0.25	0.02	7	0.23	0.04	7
NO_2-N	< 0.01	-	1	< 0.02	-	1	< 0.01	-	1
NH_3-N	< 0.03	-	1	< 0.03	-	1	< 0.03		1
F	0.20	0.10	7	0.10	0.00	7	0.8	0.00	7
pH (lab)	8.45	6.88	7	8.30	6.31	7	8.23	6.29	7
pH (field)	8.50	8.20	7	8.60	8.10	7	8.60	8.10	7
F°	51.00	40.00	7	51.00	37.00	7	50.00	41.00	7
Dis. Sol.	329.20	191.60	7	305.80	146.60	7	323.20	201.70	7
Hard.	205.00	113.00	7	190.00	86.00	7	211.00	124.00	7
Alk.	200.00	102.00	7	204.00	79.00	7	196.00	118.00	7
D. O.	10.90	9.30	7	11.30	9.30	7	10.30	9.10	7
JTU	105.00	0.00	7	30.00	0.00	7	20.00	0.00	7
T. Susp. Sol.[b]	219.62	2.33	7	70.85	1.22	6	42.10	0.30	7
V. Susp. Sol.[b]	13.80	0.70	7	6.53	0.60	6	5.80	0.20	7
Zn-Total	0.02	< 0.01	7	0.01	< 0.01	7	0.01	< 0.01	7
Zn-Dissolved	< 0.01	< 0.01	7	< 0.01	< 0.01	7	< 0.01	< 0.01	7
Cd-Total	< 0.01	< 0.01	7	< 0.01	< 0.01	7	< 0.01	< 0.01	7
Cd-Dissolved	< 0.01	< 0.01	7	< 0.01	< 0.01	7	< 0.01	< 0.01	7
Cu-Total	0.01	< 0.01	7	0.01	< 0.01	7	< 0.01	< 0.01	7
Cu-Dissolved	< 0.01	< 0.01	7	< 0.01	< 0.01	7	< 0.01	< 0.01	7
Ni-Total	0.01	< 0.01	7	< 0.01	< 0.01	7	0.02	< 0.01	7
Ni-Dissolved	< 0.01	< 0.01	7	< 0.01	< 0.01	7	0.02	< 0.01	7
Fe-Dissolved	0.28	0.00	7	0.09	0.00	7	0.02	0.00	7

Appendix G continued ( ). Summarization of water quality data for stations on West Fork Stillwater River tributaries, 1975 and 1976[a].

	CASTLE CREEK STATION 080			CASTLE CREEK STATION 079			CASTLE CREEK STATION 077		
	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples
Mn-Dissolved	0.01	0.00	7	< 0.01	0.00	7	< 0.01	0.00	7
Al-Total	5.02	< 0.05	7	1.21	< 0.05	7	0.43	< 0.05	7
Al-Dissolved	0.12	< 0.05	7	0.09	< 0.05	7	0.17	< 0.05	7

SAMPLING DATES	SAMPLING DATES	SAMPLING DATES
06-20-75	06-20-75	06-20-75
07-23-75	07-23-75	07-23-75
08-14-75	08-14-75	08-14-75
09-09-75	09-09-75	09-09-75
10-07-75	10-07-75	10-07-75
12-05-75	12-05-75	12-05-75
03-09-76	03-09-75	03-09-75

a/ Units are milligrams per liter except as indicated.

b/ Abbreviations: T. Susp. Sol. = total suspended solids; V. Susp. Sol. = volatile suspended solids.

Appendix G continued ( ). Summarization of water quality data for stations on West Fork Stillwater River tributaries, 1975 and 1976[a].

	PICKET PIN CREEK STATION 078			SADERBOLM CREEK STATION 083			CATHEDRAL CREEK STATION 018		
	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples
Ca	43.66	18.40	7	2.56	1.40	3	4.01	2.70	3
Mg	13.90	5.30	7	1.26	0.20	3	2.96	1.50	3
Na	1.50	1.10	7	1.40	0.80	3	1.80	1.30	3
K	0.80	0.40	7	0.80	0.40	3	0.60	0.50	3
SiO_2	8.10	6.20	7	5.80	3.20	3	10.90	9.20	3
HCO_3	176.90	68.00	7	12.32	7.00	3	29.16	17.00	3
CO_3	2.00	0.00	7	0.00	0.00	3	0.00	0.00	3
Cl	1.40	0.00	7	1.85	0.30	3	1.40	0.30	3
SO_4	21.78	6.00	7	4.10	1.40	3	3.90	2.00	3
NO_3-N	0.29	0.04	7	0.27	0.02	3	0.23	0.00	3
NO_2-N	< 0.01	-	1	-	-	0	-	-	0
NH_3-N	< 0.03	-	1	-	-	0	-	-	0
F	0.10	0.00	7	< 0.10	0.00	0	< 0.10	0.00	0
pH (lab)	8.41	6.56	7	6.89	6.03	3	7.35	5.98	3
pH (field)	8.60	8.20	7	7.00	6.70	3	8.50	7.30	13[d]
F°	50.00	38.00	7	50.00	42.00	3	45.00	38.00	3
Dis. Sol.	264.9	107.40	7	30.3	16.1	3	54.8	35.40	3
Hard.	161.00	63.00	7	12.00	4.00	3	22.00	13.00	3
Alk.	172.00	56.00	7	12.00	6.00	3	29.00	14.00	3
D. O.	11.00	9.40	7	9.70	8.30	3	10.20	9.70	3
JTU	4.00	0.00	7	0.00	0.00	3	5.00	0.00	11[d]
T. Susp. Sol.	12.19	0.10	7	1.10	0.20	3	1.20	< 0.10	13[d]
V. Susp. Sol.	2.50	< 0.10	7	0.40	0.20	3	0.80	< 0.10	13[d]
Zn-Total	0.01	< 0.01	7	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Zn-Dissolved	0.01	< 0.01	7	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Cd-Total	< 0.01	< 0.01	7	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Cd-Dissolved	< 0.01	< 0.01	7	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Cu-Total	0.01	< 0.01	7	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Cu-Dissolved	0.01	< 0.01	7	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Ni-Total	0.03	< 0.01	7	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Ni-Dissolved	0.02	< 0.01	7	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Fe-Dissolved	0.02	0.00	7	0.03	0.01	3	0.05	0.00	3

Appendix G continued ( ). Summarization of water quality data for stations on West Fork Stillwater River tributaries, 1975 and 1976[a].

	PICKET PIN CREEK STATION 078			SADERBOLM CREEK STATION 083			CATHEDRAL CREEK STATION 018		
	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples
Mn-Dissolved	< 0.01	0.00	7	< 0.01	0.00	3	< 0.01	0.00	3
Al-Total	0.25	< 0.05	7	-	-	0	0.14[c]	< 0.05[c]	3
Al-Dissolved	0.14	< 0.05	7	-	-	0	0.16[c]	0.05[c]	3

PICKET PIN CREEK STATION 078 SAMPLING DATES	SADERBOLM CREEK STATION 083 SAMPLING DATES	CATHEDRAL CREEK STATION 018 SAMPLING DATES
06-20-75	07-24-75	06-21-75
07-23-75	09-15-75	08-12-75
08-14-75	10-06-75	10-06-75
09-09-75		
10-07-75		
12-05-75		
03-09-76		

c/ Anomalous values caused by inherent variability in laboratory technique at low values.

d/ Sampling period 1-75 to 3-76.

Appendix G continued ( ). Summarization of water quality data for stations on West Fork Stillwater River tributaries, 1975 and 1976[a].

	UNNAMED TRIBUTARY STATION 073			DRAINAGE FROM ADIT STATION 075		
	Max.	Min.	No. of Samples	Max.	Min.	No. of Samples
Ca	36.00	23.00	3	119.00	6.81	3
Mg	5.30	4.10	3	39.00	0.30	3
Na	1.70	1.20	3	29.80	24.50	3
K	0.70	0.60	3	1.50	0.10	3
SiO_2	9.80	8.40	3	18.80	14.30	3
HCO_3	126.00	86.00	3	115.00	0.00	3
CO_3	0.00	0.00	3	13.10	0.00	3
Cl	0.60	0.40	3	14.50	4.05	3
SO_4	10.30	7.10	3	25.90	7.50	3
NO_3-N	0.04	0.02	3	144.64	1.06	4
NO_2-N	-	-	0	2.90	0.12	3
NH_3-N	-	-	0	1.43	1.00	2
F	0.00	0.00	3	0.10	0.00	3
pH (lab)	7.71	7.29	3	10.34	7.66	3
pH (field)	8.50	7.60	3	9.90	7.70	3
F°	39.00	34.00	3	52.00	40.00	3
Dis. Sol.	188.70	133.60	3	981.00	51.50	4
Hard.	111.00	77.00	3	454.00	18.00	3
Alk.	103.00	71.00	3	95.00	22.00	3
D. O.	9.10	-	1	8.50	7.00	4
JTU	5.00	0.00	2	285.00	42.00	4
T. Susp. Sol.	1.40	0.91	3	641.80	62.37	3
V. Susp. Sol.	0.70	0.50	3	23.60	2.89	3
Zn-Total	< 0.01	< 0.01	3	0.03	< 0.01	3
Zn-Dissolved	< 0.01	< 0.01	3	0.01	< 0.01	3
Cd-Total	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Cd-Dissolved	< 0.01	< 0.01	3	< 0.01	< 0.01	3
Cu-Total	< 0.01	< 0.01	3	0.05	< 0.01	3
Cu-Dissolved	< 0.01	< 0.01	3	0.02	< 0.01	3
Ni-Total	< 0.01	< 0.01	3	0.22	< 0.01	3
Ni-Dissolved	< 0.01	< 0.01	3	0.05	< 0.01	3
Fe-Dissolved	0.03	0.00	3	0.33	< 0.01	3
Mn-Dissolved	0.00	0.00	3	0.07	< 0.01	3
Al-Total	0.17	0.08	2	35.30	2.52	3
Al-Dissolved	0.10	0.08	2	0.26	0.14	3

SAMPLING DATES	SAMPLING DATES
04-23-75	06-21-75
05-13-75	01-12-76 (NO_3-N, Dis.Sol., DO, JTU only)
06-22-75	02-09-76
	03-08-76

Appendix H. Summarization of water quality data for stations on the Deer Creeks, 1972 - 1973[a].

UPPER DEER CREEK[b] STATION 022	Mean	Max.	Min.	LOWER DEER CREEK[b] STATION 021 Mean	Max.	Min.
Ca	34.00	42.00	28.00	27.00	35.00	23.00
Mg	5.20	6.30	4.30	4.10	5.00	3.40
Na	4.80	6.80	3.40	4.00	5.80	3.00
K	0.41	0.45	0.39	0.34	0.40	0.28
SiO_2	12.60	13.70	12.00	13.60	14.00	13.00
HCO_3	120.00	149.00	100.00	91.00	123.00	84.00
CO_3	0.00	0.00	0.00	0.00	0.00	0.00
OH	0.00	0.00	0.00	0.00	0.00	0.00
Cl	0.40	0.60	0.30	0.70	1.60	0.20
SO_4	16.70	24.00	12.20	13.30	19.00	9.50
NO_3-N	0.02	0.04	0.00	0.07	0.16	0.00
F	0.00	0.00	0.00	0.00	0.00	0.00
pH (lab)	7.62	8.20	7.13	7.59	7.98	7.34
pH (field)	8.50	8.60	8.30	8.40	8.50	8.40
F^o	47.00	49.00	43.00	45.00	48.00	42.00
Dis. Sol.	195.00	243.50	160.90	161.50	204.60	137.20
Hard.	106.00	123.00	87.00	85.00	107.00	71.00
Alk.	99.00	123.00	82.00	80.00	101.00	69.00
D. O.	10.00	10.30	9.80	10.20	10.50	9.80
JTU	8.00	13.00	5.00	3.00	5.00	0.00
Zn	-	< 0.01	< 0.01	-	< 0.02	< 0.01
Cd	-	< 0.01	< 0.01	-	< 0.01	< 0.01
Cu	-	< 0.02	< 0.01	-	< 0.02	< 0.01
Ni	-	< 0.05	< 0.02	-	< 0.05	< 0.02
Fe	0.17	0.37	0.01	0.06	0.10	0.02
Mn	0.00	0.01	0.00	0.00	0.01	0.00

SAMPLING DATES	SAMPLING DATES
05-26-72	05-26-72
06-01-73	06-01-73
09-28-73	09-28-73

a/ Units are milligrams per liter except as indicated.

b/ Three samples except two for zinc, cadmium, copper, and nickel.

Appendix I. Summarization of water quality data for stations on East Boulder River tributaries, 1973 - 1974[a].

	FORGE CREEK STATION 051				BROWNLEE CREEK STATION 053				BROWNLEE CREEK STATION 060			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Ca	3.60	4.90	1.30	6	5.10	7.20	3.40	3	5.30	6.90	3.80	4
Mg	3.20	4.10	1.60	6	2.80	3.40	2.20	3	3.10	3.90	1.80	4
Na	0.80	0.90	0.70	6	0.80	1.00	0.60	3	0.70	0.80	0.50	4
K	0.30	0.40	0.20	6	0.10	0.20	0.10	3	0.10	0.10	0.10	4
SiO_2	7.50	9.40	6.20	6	6.60	7.70	5.90	3	6.40	7.30	5.70	4
HCO_3	23.00	27.00	15.00	6	26.00	33.00	19.00	3	29.00	36.00	19.00	4
CO_3	0.00	0.00	0.00	6	0.00	0.00	0.00	3	0.00	0.00	0.00	4
OH	0.00	0.00	0.00	3	0.00	0.00	0.00	3	0.00	0.00	0.00	4
Cl	0.80	1.20	0.20	6	0.60	0.90	0.03	3	0.50	0.70	0.30	4
SO_4	3.70	6.30	0.20	6	4.20	5.20	2.60	3	2.70	6.00	0.60	4
NO_3-N	0.04	0.11	0.00	6	0.02	0.04	0.00	3	0.07	0.23	0.02	4
F	0.00	0.00	0.00	6	0.00	0.00	0.00	3	0.00	0.00	0.00	4
pH (lab)	7.37	7.69	7.09	6	7.23	7.37	7.09	3	7.35	7.80	6.99	4
pH (field)	8.00	8.50	7.30	6	8.00	8.50	7.50	3	8.20	8.50	7.60	4
F°	48.00	50.00	40.00	5	46.00	50.00	39.00	3	45.00	54.00	38.00	4
Dis. Sol.	42.30	49.10	30.90	6	48.30	62.00	36.90	3	47.60	59.10	32.10	4
Hard.	22.00	27.00	14.00	6	24.00	32.00	18.00	3	25.00	33.00	17.00	4
Alk.	18.00	22.00	12.00	6	22.00	27.00	16.00	3	23.00	30.00	16.00	4
D. O.	8.80	9.60	7.80	6	9.20	10.20	8.50	3	9.30	9.90	8.50	3
JTU	3.00	13.00	0.00	6	0.00	1.00	0.00	3	0.00	1.00	0.00	4
Zn	<0.01	<0.01	<0.01	6	<0.01	<0.01	<0.01	3	<0.01	<0.01	<0.01	4
Cd	<0.01	<0.01	<0.01	6	<0.01	<0.01	<0.01	3	<0.01	<0.01	<0.01	4
Cu	<0.01	<0.02	<0.01	6	<0.01	<0.01	<0.01	3	<0.01	<0.01	<0.01	4
Ni	<0.05	<0.05	<0.01	6	<0.01	<0.01	<0.01	3	<0.01	<0.01	<0.01	4
Fe	0.02	0.10	0.00	6	0.01	0.02	0.00	3	0.00	0.00	0.00	4
Mn	0.00	0.00	0.00	6	0.00	0.00	0.00	3	0.00	0.00	0.00	4

Appendix I continued ( ). Summarization of water quality data for stations on East Boulder River tributaries, 1973 - 1974[a].

FORGE CREEK STATION 051					BROWNLEE CREEK STATION 053					BROWNLESS CREEK STATION 060				
	Mean	Max.	Min.	No. of Samples		Mean	Max.	Min.	No. of Samples		Mean	Max.	Min.	No. of Samples
SAMPLING DATES					SAMPLING DATES					SAMPLING DATES				
07-25-73					07-16-74					07-26-74				
09-20-73					08-06-74					08-08-74				
10-23-73					10-03-74					09-18-74				
07-24-74										10-10-74				
09-18-74														
10-10-74														

a/ Units are milligrams per liter except as indicated.

Appendix J. Summarization of water quality data for stations on Boulder River tributaries, 1972 and 1974[a].

	BOBCAT (EAST CHIPPY) CREEK STATION 023[b]		GREAT FALLS CREEK STATION 026[b]		FALLS CREEK STATION 027[b]	
	Max.	Min.	Max.	Min.	Max.	Min.
Ca	10.80	8.30	6.40	4.20	7.90	4.60
Mg	4.10	3.00	0.80	0.00	1.20	1.00
Na	0.83	0.83	2.10	1.10	3.00	1.10
K	0.67	0.64	0.94	0.92	1.00	0.90
SiO_2	10.00	9.50	8.60	5.90	7.10	5.90
HCO_3	42.00	33.00	16.00	14.00	22.00	17.00
CO_3	0.00	0.00	0.00	0.00	0.00	0.00
OH	0.00	0.00	0.00	0.00	0.00	0.00
Cl	0.40	0.30	0.30	0.20	1.50	0.20
SO_4	14.30	6.80	11.60	6.60	12.00	4.00
NO_3-N	0.18	0.02	0.14	0.00	0.18	0.04
F	0.00	0.00	0.00	0.00	0.00	0.00
pH (lab)	6.82	-	6.66	6.37	7.17	6.37
pH (field)	8.50	8.20	8.40	7.80	8.40	8.40
F°	40.00	32.00	40.00	32.00	40.00	33.00
Dis.ol.	84.00	53.90	46.90	33.80	56.20	35.40
Hard.	44.00	33.00	16.00	14.00	24.00	15.00
Alk.	34.00	27.00	13.00	11.00	18.00	14.00
D. O.	12.10	10.50	10.60	10.10	11.80	10.50
JTU	1.00	0.00	2.00	0.00	2.00	0.00
Zn	0.015	< 0.01	0.01	< 0.01	0.01	< 0.01
Cd	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cu	0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Fe	0.02	0.02	0.08	0.02	0.09	0.02
Mn	0.00	0.00	0.00	0.00	0.00	0.00

SAMPLING DATES	SAMPLING DATES	SAMPLING DATES
05-17-72	05-18-72	05-18-72
11-27-72	08-16-72	11-30-72

a/ Units are milligrams per liter except as indicated.

b/ Two samples per station except for lab pH, which is one at station 023.

Appendix J continued ( ). Summarization of water quality data for stations on Boulder River tributaries, 1972 and 1974[a].

	BLAKELY CREEK STATION 024				GRAHAM CREEK STATION 025			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Ca	12.5	13.8	9.9	6	12.7	15.2	9.9	4
Mg	7.5	8.8	4.9	6	3.6	4.5	1.9	4
Na	1.3	1.4	0.97	6	1.8	2.2	1.3	4
K	0.36	0.4	0.26	6	0.22	0.3	0.18	4
SiO_2	10.1	11.4	9.2	6	10.0	11.4	8.3	4
HCO_3	69	78	50	6	53	63	38	4
CO_3	0	0	0	6	0	0	0	4
OH	0	0	0	6	0	0	0	4
Cl	0.7	0.9	0.4	6	0.6	0.7	0.5	4
SO_4	5.9	9.2	4.4	6	6.0	10.6	3.2	4
NO_3-N	0.02	0.04	0.0	6	0.04	0.09	0.0	4
F	0.0	0.0	0.0	6	0.0	0.0	0.0	4
pH (lab)	7.72	7.95	7.08	5	7.45	7.85	6.79	3
pH (field)	8.4	8.6	8.1	6	8.4	8.7	8.1	4
F^o	41	46	32	6	39	48	32	4
Dis. Sol.	107.8	118.4	80.7	6	88.4	100.6	64.0	4
Hard.	62.5	70	45	6	46	55	32	4
Alk.	57	64	41	6	43	51	31	4
D. O.	10.6	11.9	9.6	6	10.8	11.6	9.6	4
JTU	0	2	0	6	0	1	0	4
Zn	<0.01	0.01	<0.01	6	<0.01	0.01	<0.01	4
Cd	<0.01	<0.01	<0.01	6	<0.01	<0.01	<0.01	4
Cu	<0.01	0.01	<0.01	6	<0.01	<0.01	<0.01	4
Ni	<0.01	<0.02	<0.01	6	<0.01	<0.02	<0.01	4
Fe	0.01	0.02	0.00	6	0.13	0.50	0.00	4
Mn	0.00	0.01	0.00	6	0.00	0.01	0.00	4

Appendix J continued ( ). Summarization of water quality data for stations on Boulder River tributaries, 1972 and 1974[a].

BLAKELY CREEK STATION 024	Mean	Max.	Min.	No. of Samples	GRAHAM CREEK STATION 025	Mean	Max.	Min.	No. of Samples
SAMPLING DATES					SAMPLING DATES				
05-17-72					05-18-72				
11-27-72					11-27-72				
05-14-74					05-14-74				
07-29-74					07-29-74				
09-17-74									
10-09-74									

Appendix K. Summarization of water quality data for stations on Boulder River tributaries, 1975[a].

	FROZE-TO-DEATH CREEK STATION 084[b]		HAWLEY CREEK STATION 085[b]	
	Max.	Min.	Max.	Min.
Ca	10.01	5.20	7.61	3.50
Mg	1.75	1.00	2.43	1.20
Na	1.70	1.10	1.50	0.80
K	1.20	0.90	0.90	0.60
SiO_2	8.10	5.10	6.50	4.30
HCO_3	31.35	19.00	29.77	15.00
CO_3	0.00	0.00	0.00	0.00
Cl	0.70	0.25	0.50	0.30
SO_4	9.30	5.10	6.20	3.10
NO_3-N	0.23	0.04	0.25	0.00
F	< 0.10	0.00	< 0.10	0.00
pH (lab)	7.16	6.05	6.82	5.98
pH (field)	8.30	8.20	8.40	7.80
F°	46.00	38.00	46.00	36.00
Dis. Sol.	63.80	38.90	55.40	29.00
Hard.	32.00	17.00	29.00	14.00
Alk.	31.00	16.00	30.00	12.00
D. O.	10.80	9.90	11.20	9.70
JTU	6.00	0.00	1.00	0.00
T. Susp. Sol.[c]	1.50	0.40	1.80	0.30
V. Susp. Sol.[d]	0.80	0.40	0.80	0.20
Zn-Total	< 0.01	< 0.01	< 0.01	< 0.01
Zn-Dissolved	< 0.01	< 0.01	< 0.01	< 0.01
Cd-Total	< 0.01	< 0.01	< 0.01	< 0.01
Cd-Dissolved	< 0.01	< 0.01	< 0.01	< 0.01
Cu-Total	< 0.01	< 0.01	< 0.01	< 0.01
Cu-Dissolved	< 0.01	< 0.01	< 0.01	< 0.01
Ni-Total	< 0.01	< 0.01	< 0.01	< 0.01
Ni-Dissolved	< 0.01	< 0.01	< 0.01	< 0.01
Fe-Dissolved	< 0.01	0.00	0.01	0.00
Mn-Dissolved	< 0.01	0.00	< 0.01	0.00

SAMPLING DATES	SAMPLING DATES
07-25-75	07-25-75
08-13-75	08-13-75
10-08-75	10-08-75

a/ Units are milligrams per liter except as indicated.
b/ Three samples per station.
c/ T. Susp. Sol. = total suspended solids.
d/ V. Susp. Sol. = Volatile suspended solids.

Appendix L. Suspended solids data for stations on major streams, 1974[a].

STILLWATER RIVER	STATION 034			STATION 006			STATION 005		
	Total	Vola-tile	%Vola-tile	Total	Vola-tile	%Vola-tile	Total	Vola-tile	%Vola-tile
March	0.59	0.27	45.8	0.52	0.30	57.7	0.94	0.35	37.2
April	0.95	0.47	49.5	0.97	0.41	42.3	0.68	0.24	35.3
May (early)	2.96	1.22	41.2	2.15	1.13	52.6	0.90	0.90	100.0
May (late)	18.17	3.08	17.0	9.90	2.30	23.2	7.52	2.31	30.7
June (early)	9.90	1.80	18.2	5.10	1.10	21.6	4.41	0.90	20.4
June (mid)	106.74	10.46	9.8	32.72	5.15	15.7	82.51	11.36	13.8
June (late)	20.30	1.71	8.4	7.98	1.40	17.5	7.74	0.90	11.6
July	3.6	1.8	50.0	2.0	0.8	40.0	1.4	0.6	42.9
August	1.9	0.5	26.3	1.9	0.8	42.1	0.7	0.6	85.7
September	0.10	0.10	100.0	0.10	0.10	100.0	0.6	0.5	83.3
October	0.30	0.30	100.0	0.70	0.40	57.1	< 0.10	< 0.10	100.0
November	1.10	0.40	36.4	0.70	0.40	57.1	0.30	0.10	33.3
December	0.80	0.50	62.5	0.50	0.50	100.0	0.70	0.30	42.9

WEST FORK STILLWATER RIVER	STATION 007			STATION 037		
	Total	Vola-tile	%Volta-tile	Total	Vola-tile	%Volta-tile
March	0.24	0.16	66.7			
April	0.20	0.18	90.0			
May (early)	0.51	0.41	80.4			
May (late)	5.27	1.10	20.9	5.96	1.29	21.6
June (early)	2.59	0.70	27.0	3.21	0.60	18.7
June (mid)	59.81	6.75	11.3	53.46	5.02	9.4
June (late)	14.10	1.30	9.2	19.10	2.00	10.5
July	1.1	0.4	36.4	1.0	0.4	40.0
August	0.9	0.6	66.7	0.5	0.4	80.0
September	0.40	0.20	50.0	0.4	0.3	75.0
October	0.20	0.20	100.0	0.50	0.20	40.0
November	0.40	0.40	100.0	0.20	0.20	100.0
December	0.60	0.60	100.0	0.30	0.20	66.7

Appendix L continued ( ). Suspended solids data for stations on major streams, 1974[a].

EAST BOULDER RIVER	STATION 008			STATION 061		
	Total	Volatile	%Volatile	Total	Volatile	%Volatile
March	0.35	0.29	82.9			
April	0.22	0.17	77.3			
May (early)	1.01	0.91	90.0			
May (late)	6.81	2.10	30.8	4.17	1.49	35.7
June (early)	5.80	3.30	56.9	9.40	1.20	12.8
June (mid)	33.63	4.82	14.3	47.84	5.96	12.5
June (late)	4.51	1.00	22.2	4.50	0.90	20.0
July	0.5	0.3	60.0			
August	1.1	1.0	90.9	0.6	0.4	66.7
September	0.10	0.10	100.0	0.30	0.30	100.0
October	0.20	0.20	100.0	0.20	0.20	100.0
November	0.30	0.30	100.0			
December	0.30	0.30	100.0			

BOULDER RIVER	STATION 010			STATION 011		
	Total	Volatile	%Volatile	Total	Volatile	%Volatile
March	0.53	0.29	54.7	0.44	0.29	65.9
April	0.31	0.27	87.1	0.31	0.29	93.5
May (early)	5.96	1.52	25.5	3.01	1.10	36.5
May (late)	22.35	3.11	13.9	18.14	2.71	14.9
June (early)	14.2	2.3	16.2	2.60	1.00	38.4
June (mid)	192.16	11.36	5.9	142.67	9.83	6.9
June (late)	30.70	2.40	7.8	30.20	2.10	6.9
July	1.3	0.7	53.8	0.9	0.4	44.4
August	0.5	0.4	80.0	0.8	0.5	62.5
September	0.5	0.4	80.0	0.10	0.10	100.0
October	0.6	0.2	33.3	0.40	0.30	75.0
November	0.3	0.3	100.0	0.10	0.10	100.0
December	0.5	0.3	60.0	0.50	0.30	60.0

a/ Units are milligrams per liter.

Appendix M. Total and dissolved concentrations (parts-per-billion) of metals for samples collected at eleven stations in 1973.

COLLECTION DATE	COPPER Total	COPPER Dis.	LEAD Total	LEAD Dis.	NICKEL Total	NICKEL Dis.	CADMIUM Total	CADMIUM Dis.
EAST ROSEBUD RIVER - STATION 001								
March	7	1	< 5	< 5	21	< 5	< 1	< 1
May	3	< 1	10	< 5	< 5	< 5	< 1	< 1
July	< 2	< 2	< 5	< 5	< 5	< 5	< 1	< 1
August	< 2	< 2	< 5	< 5	< 5	< 5	< 1	< 1
September	4	3	5	2	4	< 1	< 1	< 1
EAST ROSEBUD RIVER - STATION 002								
March	7	1	5	5	11	< 5	< 1	< 1
May	6	1	6	< 5	12	< 5	< 1	< 1
July	6	6	< 5	< 5	< 5	< 5	< 1	< 1
August	< 2	< 2	< 5	< 5	< 5	< 5	< 1	< 1
September	3	2	10	< 1	3	2	< 1	< 1
WEST ROSEBUD RIVER - STATION 003								
March	5	1	< 5	< 5	24	< 5	< 1	< 1
May	5	< 1	< 5	< 5	< 5	< 5	< 1	< 1
July	2	2	< 5	< 5	< 5	< 5	< 1	< 1
August	< 2	< 2	< 5	< 5	< 5	< 5	< 1	< 1
September	3	3	7	3	5	< 1	< 1	< 1
WEST ROSEBUD RIVER - STATION 004								
March	19	1	< 5	< 5	11	< 5	< 1	< 1
May	9	1	< 5	< 5	< 5	< 5	< 1	< 1
July	6	4	< 5	< 5	< 5	< 5	< 1	< 1
August	< 2	< 2	< 5	< 5	< 5	< 5	< 1	< 1
September	9	2	9	1	6	2	< 1	< 1
STILLWATER RIVER - STATION 005								
March	4	2	< 5	< 5	15	< 5	< 1	< 1
May	17	3	< 5	< 5	< 5	< 5	< 1	< 1
July	< 2	< 2	< 5	< 5	< 5	< 5	< 1	< 1
August	3	3	< 5	< 5	< 5	< 5	< 1	< 1
September	4	4	12	< 1	4	2	< 1	< 1
October	3	1	4	3	< 1	< 1	< 1	< 1
STILLWATER RIVER - STATION 006								
March	3	3	< 5	< 5	16	< 5	< 1	< 1
May	6	3	< 5	< 5	7	7	< 1	< 1
July	7	< 2	< 5	< 5	< 5	< 5	< 1	< 1
August	4	2	< 5	< 5	< 5	< 5	< 1	< 1
September	3	3	5	< 1	6	2	< 1	< 1
October	5	< 1	5	2	< 1	< 1	< 1	< 1

Appendix M continued ( ). Total and dissolved concentrations (part-per-billion) of metals for samples collected at eleven station in 1973.

COLLECTION DATE	COPPER Total	COPPER Dis.	LEAD Total	LEAD Dis.	NICKEL Total	NICKEL Dis.	CADMIUM Total	CADMIUM Dis.
WEST FORK STILLWATER RIVER - STATION 007								
March	2	2	5	5	9	< 5	< 1	< 1
May	3	1	< 5	< 5	20	< 5	< 1	< 1
July	4	< 2	< 5	< 5	< 5	< 5	< 1	< 1
August	2	2	< 5	< 5	< 5	< 5	< 1	< 1
September	4	3	3	< 1	< 1[a]	2[a]	< 1	< 1
October	4	< 1	11	3	< 1	< 1	< 1	< 1
EAST BOULDER RIVER - STATION 038								
September	4	3	5	2	< 1[a]	2[a]	< 1	< 1
October	3	1	5	4	< 1	< 1	< 1	< 1
EAST BOULDER RIVER - STATION 008								
March	4	2	< 5	< 5	23	< 5	< 1	< 1
May	26	< 1	< 5	< 5	23	< 5	< 1	< 1
July	2	2	< 5	< 5	< 5	< 5	< 1	< 1
August	5	3	< 5	< 5	< 5	< 5	< 1	< 1
September	2	2	8	3	< 1	< 1	< 1	< 1
October	4	2	11	5	< 1	< 1	< 1	< 1
BOULDER RIVER - STATION 010								
March	6	1	< 5	< 5	9	< 5	< 1	< 1
May	4	< 1	< 5	< 5	< 5	< 5	< 1	< 1
July	3	2	< 5	< 5	10	< 5	< 1	< 1
August	< 2	< 2	< 5	< 5	7	< 5	< 1	< 1
September	2	2	8	< 1	< 1	< 1	< 1	< 1
October	4	< 1	4	2	< 1	< 1	< 1	< 1
BOULDER RIVER - STATION 011								
March	18	2	9	7	18	< 5	< 1	< 1
May	2	1	< 5	< 5	< 5	< 5	< 1	< 1
July	2	2	< 5	< 5	< 5	< 5	< 1	< 1
August	2	2	< 5	< 5	< 5	< 5	< 1	< 1
September	2	1	4	< 1	< 1	< 1	< 1	< 1
October	2	1	5	3	< 1	< 1	< 1	< 1

a/ Error of unknown source.

Appendix N. Concentration (parts-per-million) of metals in stream sediments, 1973-1974[a].

COLLECTION DATE[b]	COPPER	NICKEL	LEAD	CADMIUM	ZINC	IRON ($X10^3$)
EAST ROSEBUD RIVER - STATION 001						
March, 1973	19	30	15	1	27	15
May, 1973	20	32	16	<1	34	15
July, 1973	24	35	19	1	57	29
August, 1973	20	31	19	<1	36	26
September, 1973	22	35	32	<1	39	33
Range-all samples	13-39.5	21-52.5	15-57	<1-1	27-99.5	15-40
EAST ROSEBUD RIVER - STATION 002						
March, 1973	20	31	21	<1	33	15
May, 1973	12	21	22	<1	30	14
July, 1973	13	24	13	<1	34	20
August, 1973	11	22	15	<1	33	21
September, 1973	18	36	13	<1	48	26
Range-all samples	11-24	19.5-46	9-22	<1-1	28-55	13-32
WEST ROSEBUD RIVER - STATION 003						
March, 1973	9	18	12	<1	18	12
May, 1973	9	20	13	<1	22	9
July, 1973	9	20	50	<1	29	18
August, 1973	10	19	15	<1	32	17
September, 1973	12	29	12	<1	57	18
Range-all samples	7-16.5	16.5-42	11.5-76	<1-1	18-107.5	9-22
WEST ROSEBUD RIVER - STATION 004						
March, 1973	9	13	17	<1	18	12
May, 1973	9	16	16	<1	29	11
July, 1973	10	16	13	1	26	19
August, 1973	10	15	14	<1	38	21
September, 1973	8	16	12	<1	30	21
Range-all samples	5.5-13	10-18.5	10-17.5	<1-1	17.5-47	11-23
STILLWATER RIVER - STATION 005						
March, 1973	72	18	18	1	36	14
May, 1973	65	20	21	<1	46	11
July, 1973	48	16	25	<1	40	18
August, 1973	65	15	18	<1	55	20
September, 1973	56	14	12	<1	36	19
October, 1973	22	48	42	<1	48	25
Range-all samples	12.5-87	11-61	9.5-48.5	<1-1	24-71	11-27

Appendix N continued ( ). Concentration (parts-per-million) of metals in stream sediments, 1973-1974[a].

COLLECTION DATE[b]	COPPER	NICKEL	LEAD	CADMIUM	ZINC	IRON ($X10^3$)
STILLWATER RIVER - STATION 006						
March, 1973	46	209	19	1	20	15
May, 1973	62	192	20	<1	34	17
July, 1973	101	107	18	2	59	27
August, 1973	70	196	20	1+	50	30
September, 1973	63	209	11	<1	30	28
October, 1973	20	35	52	<1	100	22
Range-all samples	17-110	25.5-330	9.5-57	<1-3.0	20-124.5	15-36
WEST FORK STILLWATER RIVER - STATION 054						
May, 1974	49	72	28	<1	54	40
July, 1974	63	77	21	<1	54	41
September, 1974	55	84	16	1	46	40
October, 1974	43	70	16	1	47	39
Range-all samples	36-70.5	87.5-59	13.5-36.5	0.5-1.5	43.5-65.0	37.6-44.5
WEST FORK STILLWATER RIVER - STATION 007						
March, 1973	40	85	20	1	27	16
May, 1973	31	68	20	<1	30	18
July, 1973	37	78	16	1.5	34	35
August, 1973	36	77	18	1.4	36	36
September, 1973	97	123	14	<1	104	34
October, 1973	37	91	28	<1	36	32
Range-all samples	28-212	60-193	12-31	<1-1.9	25.5-254.5	16-38
EAST BOULDER RIVER - STATION 038						
September, 1973	48	138	17	1	63	61
October, 1973	50	146	38	1.1	77	66
July, 1974	62	141	26	1.5	87	68
September, 1974	45	133	23	<1	61	59
October, 1974	50	157	26	1.8	71	75
Range-all samples	41.5-69	130-168.5	16-55	1-2	49.5-94.0	53.8-77.6
EAST BOULDER RIVER - STATION 061						
July, 1974	51	84	21	1	40	43
September, 1974	38	79	19	1	34	44
October, 1974	35	71	20	1.5	56	36
Range-all samples	34-55.5	58.5-86	15.5-22.5	<1-1.5	28.5-72	31.8-45.7

Appendix N continued ( ). Concentration (parts-per-million) of metals in stream sediments, 1973-1974[a].

COLLECTION DATE[b]	COPPER	NICKEL	LEAD	CADMIUM	ZINC	IRON ($X10^3$)
BLAKELY CREEK - STATION 024						
May, 1974	65	177	32	1	35	37
July, 1974	69	159	23	< 1	36	43
September, 1974	68	161	24	1	26	33
October, 1974	71	176	22	1.2	20	40
Range-all samples	62.5-75	140-196	19-41	0.5-1.5	16-39	28-48
GRAHAM CREEK - STATION 025						
May, 1974	66	640	29	< 1	65	57
July, 1974	71	625	31	1	57	55
Range-all samples	65-74	590-705	25-38	0.5-1	43-81	52-63
CRESCENT CREEK - STATION 048						
May, 1974	195	470	21	< 1	67	63
July, 1974	233	501	22	1	74	55
Range-all samples	155-235	350-520	19.5-23	1-1	64.5-79	42-66
FORGE CREEK - STATION 051						
July, 1974	143	262	16	1	59	95
September, 1974	145	289	24	2	53	87
October, 1974	148	351	20	2	59	83
Range-all samples	120-168	234-430	12-31.5	1-2.5	43-70	81-103
BROWNLEE CREEK - STATION 053						
July, 1974	75	137	25	1	55	34
August, 1974	114	145	37	1	53	36
October, 1974	59	137	24	1	40	33
Range-all samples	49-166	128-153	21.5-43.5	1-1.5	37-57	28-41
BROWNLEE CREEK - STATION 060						
July, 1974	93	246	23	1	54	40
August, 1974	84	210	28	1	66	38
September, 1974	77	210	24	1	49	45
October, 1974	76	227	21	2	51	38
Range-all samples	72.5-112.5	189.5-309.5	18.5-29.5	1-2	34-67.5	36-48

Appendix N. continued ( ). Concentration (parts-per-million) of metals in stream sediments, 1973-1974[a].

COLLECTION DATE[b]	COPPER	NICKEL	LEAD	CADMIUM	ZINC	IRON ($X10^3$)
EAST BOULDER RIVER - STATION 008						
March, 1973	46	78	20	1	33	16
May, 1973	33	70	26	<1	38	20
July, 1973	41	76	20	1.7	50	31
August, 1973	36	76	28	1.5	49	32
September, 1973	36	74	17	1.3	34	31
October, 1973	38	80	34	<1	47	33
Range-all samples	31-46.5	58-96	14-36	<1-2.0	25.5-54	16-38
BOULDER RIVER - STATION 011						
March, 1973	21	40	14	1	30	18
May, 1973	26	45	25	<1	48	29
July, 1973	17	27	15	1.3	45	34
August, 1973	17	30	20	1.1	38	35
September, 1973	17	27	12	1.1	37	34
October, 1973	72	101	28	<1	53	35
Range-all samples	13.5-81	23.5-143	9-32.5	<1-2.0	20-72.5	18-43
BOULDER RIVER - STATION 010						
March, 1973	25	57	19	1	29	18
May, 1973	24	54	20	<1	40	30
July, 1973	20	44	14	1	44	45
August, 1973	19	40	19	1	37	39
September, 1973	22	49	13	1	44	38
October, 1973	126	46	42	<1	90	41
Range-all samples	20-132.5	36-85	10.5-64	<1-1.3	29-141.5	18-50
IRON CREEK - STATION 019						
May, 1974	45	109	25	1	48	31
July, 1974	43	113	24	<1	44	31
September, 1974	45	110	20	1	37	27
October, 1974	39	111	36	1	23	29
Range-all samples	36.5-55	102-126.5	17-72	<1-1.5	21.5-49	26-37
PICKET PIN CREEK - STATION 020						
May, 1974	57	78	29	1	99	29
July, 1974	53	76	59	1.5	53	22
September, 1974	50	71	23	1	69	26
October, 1974	55	85	24	1	43	27
Range-all samples	44-65	62.5-89.5	19-79.5	1-2	20.5-157	19-30

Appendix N. continued ( ). Concentration (parts-per-million) of metals in stream sediments, 1973-1974[a].

COLLECTION DATE[b]	COPPER	NICKEL	LEAD	CADMIUM	ZINC	IRON ($X10^3$)

a/ Fractions of field samples passing through 100 mesh per inch screening were retained for analysis.

b/ Values for March and May 1973 are for single samples; the remainder are average for three samples.

APPENDIX O. Concentration (parts-per-million) of metals in stream sediment, 1975 and 1976[a].

COLLECTION DATE[b]	COPPER	NICKEL	LEAD	CADMIUM	ZINC	IRON ($X10^3$)	ALUMINUM ($X10^3$)
WEST FORK STILLWATER RIVER - STATION 070							
4-23-75	45	89	15	0.5	70	30	-
5-13-75	46	87	20	0.6	63	37	15
6-05-75	38	70	22	0.5	64	31	14
7-24-75	30	70	15	< 0.5	34	39	10
9-11-75	50	78	16	< 0.5	54	36	15
Range-all samples	30-59	62-101	11-27	0.3-0.9	34-92	26-39	10-17
WEST FORK STILLWATER RIVER - STATION 072							
4-23-75	41	111	17	0.7	51	25	-
5-13-75	41	108	22	0.5	43	29	21
6-05-75	38	82	25	0.3	43	33	14
7-24-75	41	86	14	1.0	48	37	16
9-11-75	48	102	12	0.5	180	38	17
Range-all samples	32-48	82-119	12-27	0.2-1.0	37-180	23-38	12-23
WEST FORK STILLWATER RIVER - STATION 037							
4-23-75	44	100	17	0.6	54	27	-
5-13-75	41	96	32	0.5	56	33	15
6-05-75	42	100	25	0.6	57	30	16
7-24-75	48	88	16	0.5	53	40	17
9-11-75	48	91	19	0.5	46	45	15
Range-all samples	37-49	78-117	16-56	0.5-0.7	46-69	26-45	12-18
WEST FORK STILLWATER RIVER - STATION 076							
7-23-75	22	51	14	0.5	52	38	14
9-09-75	21	42	15	1.0	56	33	13
3-09-76	32	53	23	0.5	78	33	18

APPENDIX O. continuted ( ). Concentration (part-per-million) of metals in stream sediment, 1975 and 1976[a].

COLLECTION DATE[b]	COPPER	NICKEL	LEAD	CADMIUM	ZINC	IRON ($X10^3$)	ALUMINUM ($X10^3$)
CASTLE CREEK - STATION 077							
7-23-75	12	25	18	1.0	49	21	8
9-09-75	15	22	19	1.5	50	18	7
3-09-76	19	24	25	0.5	64	25	11
CASTLE CREEK - STATION 079							
7-23-75	12	22	13	0.5	38	16	10
9-09-75	14	22	14	1.0	34	16	10
3-09-76	27	34	38	0.5	59	22	18
CASTLE CREEK - STATION 080							
7-23-75	9	16	13	< 0.5	52	32	11
9-09-75	12	17	10	1.0	56	32	11
3-09-76	16	17	55	< 0.5	65	29	11
PICKET PIN CREEK - STATION 078							
7-23-75	22	36	16	0.5	118	22	18
9-09-75	22	34	16	1.0	42	21	18
3-09-76	19	24	35	0.8	67	20	11

a/ Fraction of field samples passing through 100 mesh per inch screening were retained for analysis.

b/ Values for July, September and March are for single samples; values for April, May and June are averages for three samples.

APPENDIX P. Maximum and minimum water temperatures (F) recorded at stations in the West Fork Stillwater River drainage, 1975-1976.

	STATIONS							
DATE THERMOMETER WAS READ AND RESET[a]	WEST FORK STILLWATER RIVER				CASTLE CREEK			PICKET PIN CREEK
	076	007	037	070	080	079	077	078
07-30-75	57-52					54-48	52-46	52-46
07-31-75					54-48			
08-04-75			53-42	52-42				
08-06-75	57-46	b			57-46	54-44		
08-07-75		c	52-44	b,c			50-44	b
08-12-75	56-50		52-45					
08-14-75		--46			56-48	56-44	50-44	c
08-15-75			52-44	52-44				
08-16-75	57-48				b.c.			
08-20-75	57-48	54-46			58-49	54-44	49-44	52-44
08-21-75			52-42	53-42				
08-25-75	56-44				57-48	54-43	50-44	48-42
08-26-75		55-43						
08-28-75	56-44	54-43			58-48	54-42	51-43	52-42
08-29-75			52-43	b,c				
09-03-75	56-44		50-41	49-40	58-48	56-42	52-43	52-41

APPENDIX P. continued ( ). Maximum and minimum water temperatures (F) recorded at stations in the West Fork Stillwater River drainage, 1975-1976.

DATE THERMOMETER WAS READ AND RESET[a]	STATIONS: WEST FORK STILLWATER RIVER				CASTLE CREEK			PICKET PIN CREEK
	076	007	037	070	080	079	077	078
09-08-75		55-43						
09-09-75	56-44				57-45	56-43	48-42	53-42
09-11-75			51-41	b,c				
09-15-75						54-41		
09-16-75	55-44				56-46		47-44	50-41
09-17-75		54-42						
09-19-75			49-38	50-37				
09-22-75	54-43				53-46	54-40		
09-23-75							48-42	49-40
09-25-75	51-39				55-46	52-42		
09-26-75			46-38	46-36				
09-29-75	54-44	48-40				53-40	46-42	48-40
09-30-75			b	45-35	54-46			
10-01-75							46-42	47-39
10-06-75			c	46-36				
10-07-75	54-42	50-39			54-41	53-38	46-43	48-40

APPENDIX P. continued ( ). Maximum and minimum water temperatures (F) recorded at stations in the West Fork Stillwater River drainage, 1975-1976.

	STATIONS							
DATE THERMOMETER WAS READ AND RESET[a]	WEST FORK STILLWATER RIVER				CASTLE CREEK			PICKET PIN CREEK
	076	007	037	070	080	079	077	078
10-15-75				48-34				
10-16-75			48-36					
10-17-75	50-41	46-37			52-44	50-40	44-42	46-40
10-20-75		45-40			54-46	50-41	45-43	46-40
10-24-75	50-36	43-32			53-40	50-34	43-41	45-36
10-27-75			44-32					
10-28-75				43-32				
11-05-75		43-32			50-39	47-32	44-40	45-35
11-06-75			40-33	39-32				
11-11-75	44-38	41-32			50-40	46-33	42-38	42-36
11-14-75			38-33	38-32				
11-20-75	36-33				42-38			
11-24-75	43-34		37-32	d				
11-25-75					44-38	44-32	43-40	42-34
12-01-75	38-33	38-32						
12-02-75					40-37	38-32	43-40	40-33

APPENDIX P. continued ( ). Maximum and minimum water temperatures (F) recorded at stations in the West Fork Stillwater River drainage, 1975-1976.

DATE THERMOMETER WAS READ AND RESET[a]	STATIONS							
	WEST FORK STILLWATER RIVER				CASTLE CREEK			PICKET PIN CREEK
	076	007	037	070	080	079	077	078
12-04-75			36-32	36-32				
12-05-75	41-36	37-32			45-40	42-35	42-41	42-38
12-08-75	42-36				46-40	43-33	44-42	42-36
12-09-75		39-32	37-33	35-32				
12-15-75	43-32	40-32			47-34	b,c	43-40	42-32
12-24-75	38-33		37-32	35-32				
12-30-75	40-33	37-32	36-32	35-32	45-36	41-32	43-39	40-33
01-08-76	37-33	35-32	35-32	33-32	42-35	37-33	43-40	36-32
01-12-76		35-32	35-32	34-32				
01-14-76	37-33		35-32					
01-16-76	40-35	36-32			42-35	38-32	43-41	41-34
01-23-76	40-34	37-32	36-32	34-32	45-38	42-33	43-41	39-35
01-28-76			36-32	34-32				
01-30-76	41-33	37-32			47-36	43-32	43-41	41-33
02-07-76			36-32	34-32				
02-10-76			36-33	34-32				

APPENDIX P. continued ( ). Maximum and minimum water temperatures (F) recorded at stations in the West Fork Stillwater River drainage, 1975-1976.

DATE THERMOMETER WAS READ AND RESET[a]	STATIONS							
	WEST FORK STILLWATER RIVER				CASTLE CREEK			PICKET PIN CREEK
	076	007	037	070	080	079	077	078
02-13-76	41-33	37-32			46-34	43-33	43-41	41-32
02-18-76					46-35		43-40	40-34
02-19-76	41-33	36-32	36-33			42-33		
02-22-76			36-33	34-32				
02-24-76	42-33	37-32			47-37	43-32	43-40	40-34
03-05-76	42-32	37-32			47-34	43-32	43-40	36-33
03-08-76			37-32	37-32				
03-09-76	40-33	36-32			48-36	42-33	44-41	41-34
03-16-76		38-32	38-32	36-32				
03-17-76	43-33				50-34	47-32	44-41	42-33
03-22-76	47-33	40-32	39-33	36-32	52-37	49-33	45-41	44-34
03-26-76			39-33	37-32				
03-30-76	46-33	39-32	38-32	35-32	51-37	49-33	45-42	43-34
04-07-76	53-34				57-37	55-33	47-41	47-34
04-08-76		45-33	41-34	43-32				
04-12-76			43-36	44-34				

APPENDIX P. continued ( ). Maximum and minimum water temperatures (F) recorded at stations in the West Fork Stillwater River drainage, 1975-1976.

DATE THERMOMETER WAS READ AND RESET[a]	STATIONS							
	WEST FORK STILLWATER RIVER				CASTLE CREEK			PICKET PIN CREEK
	076	007	037	070	080	079	077	078
04-14-76			43-36					
04-16-76	54-38	47-35			59-41	57-37	47-42	48-38
04-20-76			42-33	44-32				
04-23-76	51-38	45-36			54-40	53-35	46-42	45-38
04-30-76	52-34				58-35	57-32	47-40	47-33
05-04-76			46-33	48-32				
05-05-76	53-39	49-32			55-39	55-36		
05-06-76							47-42	48-37
05-10-76		51-36			56-41	56-37	50-41	47-38
05-17-76	55-38							
05-18-76		51-35	48-33	48-32				
05-20-76			45-36	43-34				
05-21-76	53-40	48-36			56-41	b,c	48-40	48-36
05-26-76	50-38	47-36	45-35	43-34	52-42	50-38	47-39	46-37
06-03-76	b,c	50-37	47-36	46-34	54-42	51-39	48-40	48-38
06-10-76	52-38	49-39	47-38	50-36	54-44	51-41	49-41	48-40

APPENDIX P. continued ( ). Maximum and minimum water temperatures (F) recorded at stations in the West Fork Stillwater River drainage, 1975-1976.

DATE THERMOMETER WAS READ AND RESET[a]	STATIONS							
	WEST FORK STILLWATER RIVER				CASTLE CREEK			PICKET PIN CREEK
	076	007	037	070	080	079	077	078
06-17-76	46-40	b,c	46-36	b,c	50-41	49-39	46-37	49-39
06-21-76	53-42	52-39	51-38	50-36	56-44	53-39	51-41	50-40
6-28-76	52-40	50-38	49-37	49-35	54-44	52-40	49-40	50-39
07-02-76	54-45	54-42	52-40	51-38	56-46	54-44	53-43	52-42
07-05-76			51-42		56-48	53-45	52-44	52-44
07-08-76			54-42	53-41				
07-20-76	59-45	58-43	b	53-41	59-48	55-46	53-44	54-44
07-23-76	60-49	56-48	c	55-45	60-48	58-47	53-46	54-46
08-02-76	60-48	58-47	55-43	55-42	60-46	58-45	54-44	53-44

a/ Thermometers were first placed at stations 076,080,079,077 and 078 on 7-28-75 and at stations 007,037 and 070 on 7-31-75.

b/ Thermometer malfunction - no reading.

c/ Malfunctioning thermometer reset or replaced.

d/ Thermometer temporarily lost below ice.

APPENDIX Q. Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Rosebud River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
EAST ROSEBUD RIVER - STATION 001								
08-70	46	17	93	29	0	0	0	185
04-71	66(.5)	2 (T)[b]	143(.2)	7 (T)	0	0	0	218 (.7)
10-71	39(.2)	1 (T)	132(.5)	9 (.1)	0	0	1(T)	182 (.8)
10-71	8(.4)	8(.2)	43(.1)	1 (T)	0	0	0	60 (.7)
10-71	72(.2)	3(.1)	141(.6)	4 (T)	0	0	0	220 (.9)
05-72	11 (T)	2 (T)	81(.3)	12 (.1)	0	0	3(T)	109 (.4)
05-72	15 (T)	1 (T)	27(.1)	7 (.3)	0	0	5(T)	55 (.4)
05-72	3 (T)	2 (T)	22(.1)	8 (.2)	0	0	2(T)	37 (.3)
08-72	20(.2)	3 (T)	94(.2)	6 (T)	0	0	0	123 (.4)
08-72	21(.3)	9(.2)	105(.2)	18 (.3)	0	0	0	153(1.0)
08-72	55(.3)	20(.1)	190(.1)	32 (.1)	0	62(T)	0	359 (.6)
02-73	83(.4)	24(.2)	297(.9)	38(1.4)	0	0	2(T)	444(2.9)
02-73	102(.6)	18(.2)	377(.6)	28 (T)	4(T)	2(T)	0	531(1.4)
02-73	52(.1)	4(.1)	260(.8)	13 (T)	2(T)	0	0	331(1.0)
05-73	34(.1)	11 (T)	139(.4)	26 (.2)	2(T)	0	1(T)	213 (.7)
05-73	57(.2)	4 (T)	198(.8)	22 (.1)	1(T)	0	4(T)	286(1.1)
05-73	59(.5)	2(.1)	228(.9)	19 (.7)	0	0	8(T)	316(2.2)
07-73	18 (T)	4 (T)	53(.3)	6 (T)	0	0	0	81 (.3)
07-73	29(.4)	22 (T)	64(.7)	18 (.1)	0	0	2(T)	135(1.2)
07-73	53(.1)	11 (T)	103(.6)	17 (T)	0	0	0	184 (.7)
10-73	26(.1)	0	122(.2)	10 (T)	0	0	3(T)	161 (.3)
10-73	61(.1)	3 (T)	188(.2)	24 (.8)	0	0	2(T)	278(1.1)
10-73	33(.1)	6(.1)	161(.2)	22 (.2)	0	0	0	222(0.6)
EAST ROSEBUD RIVER - STATION 049								
08-70	47	0	95	17	0	0	0	159
04-71	23(.3)	57(.2)	149(.5)	12 (T)	2(T)	0	0	243(1.0)
10-71	5(.1)	16 (T)	83(.2)	5 (T)	0	0	0	109 (.3)
10-71	9(.2)	10 (T)	189(.5)	1 (T)	2(T)	0	1(T)	212 (.7)
10-71	18(.5)	12(.1)	106(.3)	6 (T)	0	0	1(T)	143 (.9)

APPENDIX Q. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Rosebud River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
EAST ROSEBUD RIVER - STATION 028								
02-72	20(.2)	100 (.7)	187 (.7)	39 (.2)	2 (T)	9 (T)	0	357(1.8)
02-72	30(.1)	92(1.0)	172(2.0)	11 (.2)	1 (T)	10 (T)	1(T)	317(3.3)
02-72	6 (T)	33 (.5)	191 (.4)	2 (T)	0	1 (T)	0	233 (.9)
05-72	3 (T)	12 (.1)	78 (.2)	3 (T)	1 (T)	0	0	97 (.3)
05-72	0	103 (.1)	26 (.1)	5 (T)	4 (T)	1 (T)	1(T)	140 (.2)
05-72	14(.1)	17 (.1)	71 (.6)	3 (T)	0	1 (T)	0	106 (.8)
08-72	12(.1)	17 (.2)	90 (.2)	18 (T)	1 (T)	0	0	138 (.5)
08-72	3 (T)	5 (T)	32 (T)	28 (.1)	1 (T)	8 (T)	0	77 (.1)
08-72	1 (T)	8 (T)	43 (.1)	9 (T)	1 (T)	2 (T)	1(T)	65 (.1)
02-73	26(.4)	98(1.2)	286(1.4)	12 (.2)	4 (T)	47 (T)	0	473(3.2)
02-73	19(.2)	104 (.4)	239(1.3)	14 (.2)	1 (T)	42 (T)	0	419(2.1)
02-73	28(.1)	136(1.8)	212(1.3)	37 (.6)	2 (T)	62 (T)	0	477(3.8)
EAST ROSEBUD RIVER - STATION 046								
10-71	17(.1)	62 (.2)	87 (.3)	10 (.1)	8 (T)	0	26(T)	210 (.7)
10-71	14(.3)	67 (.7)	94 (.2)	17 (.2)	10 (T)	0	35(T)	237(1.4)
10-71	25(.2)	99(1.1)	137 (.5)	16 (.2)	8 (T)	0	29(T)	314(2.0)
02-72	13(.1)	25 (.1)	86 (.5)	2 (.1)	0	0	0	126 (.8)
02-72	28(.1)	50 (.2)	272(1.1)	2 (T)	0	0	0	352(1.4)
02-72	14 (T)	71 (.3)	229 (.7)	1 (T)	0	0	0	315(1.0)
05-72	6(.4)	159 (.5)	141 (.5)	5 (T)	2 (T)	4(.8)	0	317(2.2)
05-72	8 (T)	92 (.1)	44 (.4)	17 (.1)	2 (T)	15 (T)	0	178 (.6)
05-72	12(.1)	36 (.3)	169 (.6)	8 (T)	1 (T)	0	0	226(1.0)
08-72	4 (T)	23 (.1)	76 (T)	46 (T)	1 (T)	3 (T)	0	153 (.1)
08-72	17 (T)	56 (.2)	153 (T)	61 (.1)	1 (T)	6 (T)	0	294 (.3)
08-72	23 (T)	30 (.1)	136 (.1)	28 (.2)	6 (T)	2 (T)	2(T)	227 (.4)
02-73	36(.2)	48 (.2)	205(1.0)	20 (.8)	0	37 (T)	1(T)	347(2.2)
02-73	9 (T)	15 (.1)	195 (.8)	52(1.7)	0	0	0	271(2.6)
02-73	25(.4)	45 (.3)	134 (.7)	46(1.3)	1 (T)	9 (T)	3(T)	263(2.7)
05-73	5(.1)	87 (.7)	74 (.3)	43 (.2)	1 (T)	148 (T)	0	358(1.3)
05-73	7(.1)	90 (T)	146 (.2)	30 (.1)	7 (T)	278(.1)	0	558 (.5)
05-73	24(.4)	32 (T)	84 (.2)	21 (.1)	5 (T)	28 (T)	0	194 (.7)

APPENDIX Q. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Rosebud River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
EAST ROSEBUD RIVER - STATION 046								
08-73	8 (T)	19 (.1)	63 (.1)	47 (T)	0	1 (T)	0	138 (.2)
08-73	7 (T)	21 (.1)	95 (.2)	62 (.1)	4 (T)	21 (T)	0	210 (.4)
08-73	18(.4)	95 (.5)	148(1.4)	59 (.2)	7(.1)	19 (T)	0	346(2.6)
10-73	34(.1)	177 (.7)	154 (.1)	21 (.7)	7 (T)	158 (T)	2(T)	553(1.6)
10-73	38(.4)	145 (.6)	182 (.1)	18 (.1)	3 (T)	153(.1)	2(T)	541(1.3)
10-73	33(.1)	72 (.1)	130 (.1)	20 (.1)	15 (T)	113 (T)	1(T)	384 (.4)
WEST ROSEBUD RIVER - STATION 003								
08-70	50	3	102	31	4	5	2	197
04-71	18(.1)	17 (.3)	103(.3)	13 (T)	2 (T)	0	63(T)	216 (.7)
10-71	37(.1)	8 (.1)	106(.3)	4 (T)	3 (T)	18 (T)	0	176 (.5)
10-71	59(.4)	16 (.1)	260(.2)	9 (.1)	5 (T)	71 (T)	0	420 (.8)
10-71	62(.3)	27 (.2)	249(.3)	5 (.1)	1(.1)	15 (T)	0	359(1.0)
02-72	60(.7)	41 (.7)	288(.7)	15 (T)	4(.1)	20 (T)	4(T)	432(2.2)
02-72	155(.3)	32 (.4)	400(.8)	49 (.1)	7 (T)	54 (T)	0	697(1.6)
02-72	24(.2)	23 (.3)	350(.6)	4 (.1)	5 (T)	3 (T)	0	409(1.2)
05-72	8 (T)	11 (T)	55(.1)	23 (.1)	13 (T)	98 (T)	0	208 (.2)
05-72	20(.1)	10 (T)	146(.3)	24 (.4)	0	26 (T)	0	226 (.8)
05-72	19(.1)	10 (T)	110(.6)	18 (.1)	8 (T)	116 (T)	0	281 (.8)
08-72	94(.1)	2 (T)	59 (T)	16 (.6)	3 (T)	91 (T)	0	265 (.7)
08-72	28(.1)	1 (.1)	86(.1)	5 (T)	0	1 (T)	0	121 (.3)
08-72	60(.2)	5 (T)	162(.1)	6 (.1)	0	95(.1)	0	328 (.5)
02-73	33(.1)	14 (.2)	87(.3)	8 (.1)	5 (T)	21 (T)	0	168 (.7)
02-73	41(.3)	14 (.2)	152(.5)	37 (.4)	14 (T)	90 (T)	0	348(1.4)
02-73	163(1.1)	66(1.7)	577(1.9)	46 (.2)	10(.1)	149 (T)	0	1011(5.0)
05-73	17(.2)	20 (.3)	89(.4)	18 (T)	2 (T)	50 (T)	5(T)	201 (.9)
05-73	99(1.4)	95(3.2)	311(.6)	45 (.2)	7 (T)	61 (T)	0	618(5.4)
05-73	36(.4)	62(1.2)	136(.8)	32 (T)	6 (T)	33 (T)	3(T)	308(2.4)
07-73	40(.5)	6 (T)	111(.2)	11 (.2)	6 (T)	19 (T)	0	193 (.9)
07-73	23(.1)	2 (T)	29(.2)	6 (T)	1 (T)	13 (T)	1(T)	75 (.3)

APPENDIX Q. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Rosebud River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
WEST ROSEBUD RIVER - STATION 003								
07-73	26(.3)	2 (T)	57(.6)	9 (.1)	4 (T)	66 (T)	0	164(1.0)
10-73	70(.1)	49(.5)	201(.2)	4 (.2)	5 (T)	32 (T)	0	361(1.0)
10-73	110(1.1)	38(.4)	207(.1)	16 (.3)	3 (T)	48 (T)	4(T)	426(1.9)
10-73	112(.3)	60(.3)	135(.1)	9 (.1)	7(.1)	45 (T)	1(T)	369 (.9)
WEST ROSEBUD RIVER - STATION 029								
08-70	5	18	127	59	10	0	0	219
04-71	29(.1)	53(.3)	190(.4)	22 (T)	11 (T)	1 (T)	44(T)	350 (.8)
10-71	52(.4)	76(2.0)	167(.7)	43 (.1)	5 (T)	41 (T)	0	384(3.2)
10-71	27(.3)	101(.4)	134(.3)	38 (T)	7 (T)	35 (T)	0	342(1.0)
10-71	43(.2)	57(.5)	172(.4)	29 (.1)	6 (T)	51 (T)	0	358(1.2)
02-72	27(.2)	152(1.1)	117(.4)	5 (.1)	2 (T)	7 (T)	0	310(1.8)
02-72	25 (T)	59(.5)	76(.2)	19 (T)	3 (T)	13 (T)	1(T)	196 (.7)
02-72	24(.4)	82(.2)	98(.5)	20 (.1)	7 (T)	1 (T)	1(T)	233(1.2)
05-72	18(.5)	192(1.0)	96(1.0)	34 (.1)	10 (T)	77 (T)	1(T)	428(2.6)
05-72	21(.3)	82(.6)	123(.2)	39 (.2)	13(.1)	52(.1)	0	330(1.5)
05-72	5(.3)	108(.5)	22(.3)	22 (.1)	19 (T)	9 (T)	3(T)	188(1.2)
08-72	20(.5)	94(.2)	290(.2)	66 (T)	12 (T)	49 (T)	0	531 (.9)
08-72	1 (T)	9 (T)	57 (T)	21 (T)	11 (T)	42 (T)	3(T)	144 (T)
08-72	32 (T)	29(.1)	150(.1)	46 (T)	21 (T)	164 (T)	3(T)	445 (.2)
02-73	12 (T)	22 (T)	80(.6)	10 (T)	5 (T)	16 (T)	0	145 (.6)
02-73	8 (T)	28(.4)	51(.3)	32 (.2)	0	5 (T)	0	124 (.9)
02-73	21(.3)	18(.2)	43(.2)	16 (T)	1 (T)	9 (T)	1(T)	109 (.7)
05-73	14(.1)	17(.1)	53(.1)	64 (.7)	5 (T)	141 (T)	1(T)	295(1.0)
05-73	6 (T)	15(.1)	109(.2)	105 (.1)	5 (T)	74(.1)	0	314 (.5)
05-73	21(.2)	49(.1)	186(.3)	82 (.1)	6 (T)	102(.1)	0	446 (.8)
08-73	8 (T)	15(.2)	131(.2)	36 (.2)	7(.1)	14 (T)	0	211 (.7)
08-73	5 (T)	23(.2)	49(.1)	35 (T)	3 (T)	6 (T)	1(T)	122 (.3)
08-73	10 (T)	32(.1)	174(1.1)	66 (.1)	3 (T)	14 (T)	1(T)	300(1.3)
10-73	9 (T)	87(.8)	118(.2)	17 (.1)	6 (T)	10 (T)	0	247(1.1)
10-73	34(.3)	58(.4)	153(.1)	23 (T)	5 (T)	5 (T)	0	278 (.8)
10-73	6 (T)	67(.1)	87(.1)	51 (.1)	11 (T)	4 (T)	0	226 (.3)

APPENDIX Q. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Rosebud River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
WEST ROSEBUD RIVER - STATION 004								
08-70	28	64	62	49	4	16	1	224
04-71	39(.4)	123(1.0)	219(.7)	6 (T)	4 (T)	0	62 (T)	453(1.2)
10-71	6(.1)	12 (.1)	48(.1)	3 (T)	1 (T)	11 (T)	0	81 (.3)
10-71	7 (T)	14 (.1)	36(.1)	5 (T)	0	4 (T)	0	66 (.2)
10-71	34 (T)	20 (.2)	97(.2)	10(.1)	3(.1)	9 (T)	0	173 (.6)
02-72	14(.1)	23 (.1)	162(.5)	2 (T)	4 (T)	29 (T)	0	234 (.7)
02-72	18(.1)	28 (.2)	107(.5)	2 (T)	2 (T)	25 (T)	0	182 (.8)
02-72	16(.2)	108 (.5)	214(.8)	2(.1)	1 (T)	11 (T)	0	352(1.6)
05-72	4 (T)	6 (.1)	14(.1)	11(.1)	1 (T)	35 (T)	1 (T)	72 (.3)
05-72	7(.1)	5 (.1)	45(.3)	20(.2)	0	19(.5)	0	96(1.2)
05-72	5 (T)	8 (T)	12(.1)	17(.4)	1 (T)	52 (T)	2 (T)	97 (.5)
08-72	21 (T)	1 (T)	30 (T)	6 (T)	4(.1)	71 (T)	0	133 (.1)
08-72	17 (T)	3 (T)	38 (T)	7 (T)	1 (T)	102 (T)	0	168 (T)
08-72	16 (T)	7 (.1)	21(.1)	6(.1)	1 (T)	75 (T)	0	126 (.3)
02-73	22 (T)	43 (.1)	107(.4)	5(.1)	0	31 (T)	1 (T)	209 (.6)
02-73	50(.1)	35 (.1)	266(.9)	3 (T)	2 (T)	20 (T)	0	376(1.1)
02-73	14 (T)	54 (.1)	34(.2)	5(.3)	0	17 (T)	0	124 (.6)
05-73	10(.2)	45 (.6)	137(.3)	11(.1)	8 (T)	106 (T)	0	317(1.2)
05-73	40(.1)	162 (.2)	151(.7)	9(.4)	2 (T)	259(.1)	4 (T)	627(1.5)
05-73	40 (T)	57 (.1)	182(.6)	18(.1)	2 (T)	241 (T)	2 (T)	542 (.8)
08-73	4 (T)	3 (T)	13(.1)	5 (T)	0	23 (T)	2 (T)	50 (.1)
08-73	3 (T)	6 (T)	9(.1)	9(.1)	3 (T)	1 (T)	0	31 (.2)
08-73	8 (T)	16 (.1)	18(.1)	8(.1)	2 (T)	2 (T)	0	54 (.3)
10-73	12 (T)	62 (.2)	164(.2)	16(.2)	2 (T)	81(.1)	3 (T)	340 (.7)
10-73	12(.1)	37 (.1)	91(.2)	7 (T)	4 (T)	15 (T)	1 (T)	167 (.4)
10-73	10(.1)	28 (.1)	117(.2)	1 (T)	3 (T)	29 (T)	2 (T)	190 (.4)
MORRIS CREEK - STATION 014								
8-72	3 (T)	121 (.2)	62(.1)	25(.1)	29(.1)	3 (T)	0	243 (.5)
8-72	35 (T)	62 (.1)	95(.1)	25(.1)	21 (T)	3 (T)	0	241 (.4)
8-72	12 (T)	28 (.1)	23(.1)	14(.1)	11 (T)	1 (T)	0	89 (.4)

APPENDIX Q. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Rosebud River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
EAST FISHTAIL CREEK - STATION 012								
08-72	58(.2)	61(.3)	53(.1)	46 (T)	5 (T)	301 (T)	62(.1)	586(.7)
08-72	31 (T)	62(.2)	14(.1)	34 (T)	4 (T)	65 (T)	21(.1)	231(.4)
08-72	56 (T)	50(.1)	68(.1)	108 (T)	19 (T)	215(.1)	97(.2)	613(.5)
08-73	19(.2)	27 (T)	119(.2)	6 (T)	7 (T)	81 (T)	50(.2)	309(.6)
08-73	18(.1)	27 (T)	120(.1)	27 (T)	38(.1)	49 (T)	55(.2)	334(.5)
08-73	29 (T)	28(.2)	102(.1)	19 (T)	5 (T)	29 (T)	15(.1)	227(.4)
07-74	6 (T)	24(.1)	32(.1)	8 (T)	1 (T)	28 (T)	16 (T)	115(.2)
07-74	7 (T)	11(.1)	29(.1)	3 (T)	0 (0)	8 (T)	11 (T)	69(.2)
07-74	5 (T)	7 (T)	53(.2)	11(.1)	3 (T)	48 (T)	9 (T)	136(.3)
WEST FISHTAIL CREEK - STATION 013								
08-72	43 (T)	61(.3)	59(.1)	168 (T)	1 (T)	43 (T)	47 (T)	422(.4)
08-72	33(.1)	23(.1)	32 (T)	23 (T)	4 (T)	103 (T)	6 (T)	224(.2)
08-72	37(.3)	50(.1)	44(.2)	29(.1)	2 (T)	97 (T)	32 (T)	291(.7)
08-73	63(.2)	66(.1)	109(.4)	92 (T)	4 (T)	96 (T)	39(.1)	469(.8)
08-73	53(.7)	74(.3)	112(.2)	86 (T)	5 (T)	129(.1)	44(.1)	503(1.6)
08-73	25(.1)	19(.1)	28(.3)	18 (T)	3 (T)	131(.1)	26(.1)	250(.7)
07-74	21(.3)	9(.1)	73(.2)	23 (T)	2 (T)	7 (T)	18(.1)	153(.7)
07-74	20 (T)	29(.3)	106(.2)	22 (T)	0	12 (T)	8 (T)	197(.5)
07-74	40(.1)	36(.3)	85(.2)	31(.2)	2 (T)	18 (T)	37(.1)	249(.9)
FISHTAIL CREEK - STATION 030								
10-71	48(.4)	90(1.3)	155(.5)	5 (T)	1 (T)	104 (T)	49(.2)	452(2.4)
10-71	41(.1)	50 (.1)	96(.2)	21 (T)	9 (T)	75 (T)	16(.1)	308 (.5)
10-71	27(.2)	44 (.2)	166(.2)	8 (T)	8 (T)	91 (T)	29(.1)	373 (.7)
02-72	20(.7)	189 (.4)	211(.5)	18 (T)	3 (T)	18 (T)	16 (T)	475(1.6)
02-72	12(.1)	250 (.7)	103(.2)	4(.1)	11(.1)	92(.1)	34(.1)	506(1.4)
02-72	29(.1)	76 (.2)	96(.3)	4 (T)	7(.1)	45 (T)	13 (T)	270 (.7)
05-72	18(.1)	203(1.1)	103(.4)	46(.1)	5 (T)	91(.1)	36(.1)	502(1.9)
05-72	6(.1)	36 (.4)	42(.2)	23 (T)	1 (T)	31 (T)	0	139 (.7)
05-72	7 (T)	50 (.1)	184(.8)	12 (T)	5 (T)	109(.1)	31(.1)	398(1.1)

APPENDIX Q. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Rosebud River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
FISHTAIL CREEK - STATION 030								
08-72	8 (T)	56(.2)	80(.2)	36 (T)	4(.1)	8 (T)	17(.1)	209 (.6)
08-72	14(.1)	30(.1)	49(.1)	7 (T)	8 (T)	3 (T)	15(.1)	126 (.4)
08-72	23 (T)	38 (T)	68(.1)	39(.7)	5 (T)	30 (T)	50(.1)	253 (.9)
02-73	54(.1)	69(.2)	359(.7)	32 (T)	9 (T)	125 (T)	54(.1)	702(1.1)
02-73	144(.7)	122(1.5)	528(1.2)	97(.1)	12 (T)	289 (T)	188(.5)	1380(4.0)
02-73	49(.1)	73(.5)	269(.4)	35(.1)	10 (T)	98(.1)	85(.2)	619(1.4)
05-73	3 (T)	36(.2)	31(.2)	27 (T)	6 (T)	6 (T)	44(.1)	153 (.5)
05-73	10(.1)	64(.2)	36(.1)	60(.1)	24 (T)	11 (T)	43(.1)	248 (.6)
05-73	14 (T)	79(.3)	54(.2)	60(.1)	18 (T)	106 (T)	53(.1)	384 (.7)
08-73	27 (T)	34(.2)	33(.1)	93 (T)	3 (T)	71 (T)	58(.2)	319 (.5)
08-73	26(.8)	40(.1)	74(.3)	47 (T)	5 (T)	223 (T)	33(.1)	448(1.3)
08-73	20(.1)	27(.2)	38(.1)	17 (T)	6 (T)	136 (T)	25(.1)	269 (.5)
10-73	54(1.4)	73(.2)	170(.2)	25 (T)	11 (T)	261(.1)	49(.1)	643(2.0)
10-73	96(.2)	85(.4)	169(.1)	5(.1)	3 (T)	95 (T)	40(.1)	493 (.9)
10-73	77(.2)	47(.3)	155(.2)	19 (T)	5 (T)	172(.1)	43(.1)	518 (.9)
02-74	94(.6)	133(.3)	263(.6)	60(.1)	5 (T)	277(.1)	150(.2)	982(1.9)
05-74	4(.1)	92(.2)	57(.1)	4 (T)	1 (T)	8 (T)	14 (T)	180 (.4)
05-74	20(.2)	92(.3)	206(.5)	10 (T)	5 (T)	31 (T)	40(.1)	404(1.1)
05-74	47(.3)	147(.5)	396(.9)	69(.1)	7 (T)	151 (T)	142(.2)	959(2.0)
07-74	9 (T)	9(.2)	34(.1)	11 (T)	1 (T)	18 (T)	7 (T)	89 (.3)
07-74	13 (T)	16(.1)	52(.1)	15 (T)	7 (T)	44 (T)	46(.1)	193 (.3)
07-74	9(.2)	7 (T)	50(.1)	6 (T)	1 (T)	7 (T)	6 (T)	86 (.3)
10-74	147(.3)	305(.7)	252(.4)	61(.1)	15 (T)	300(.5)	56(.1)	1137(2.1)
10-74	19(.1)	42(.4)	313(.4)	20 (T)	4 (T)	126 (T)	28 (T)	552 (.9)
10-74	57(1.0)	66(.7)	221(.2)	32 (T)	11 (T)	219 (T)	42(.1)	648(2.0)
FISHTAIL CREEK - STATION 045								
10-71	54(.6)	120(1.2)	140(.3)	27(.3)	11(.1)	94(.1)	2 (T)	448(2.5)
10-71	28(.1)	111(1.1)	139(.2)	78(.1)	15 (T)	146(.1)	1 (T)	518(1.6)
10-71	41(.8)	102(1.1)	111(.2)	23(.1)	10 (T)	88 (T)	0	375(2.2)
02-72	35(.5)	233 (.5)	222(.6)	80(.1)	15(.1)	97(.1)	0	682(1.9)
02-72	33(.3)	215 (.4)	172(.5)	21 (T)	8(.1)	46 (T)	0	495(1.3)

APPENDIX Q. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Rosebud River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
FISHTAIL CREEK - STATION 045								
02-72	6(.1)	34 (.2)	62 (.2)	9 (.1)	6 (T)	16 (T)	0	133 (.6)
05-72	11(.4)	58 (.3)	61 (.4)	40 (.1)	19(.1)	24 (T)	3 (T)	216(1.3)
05-72	6(.1)	118 (.5)	47 (.2)	28 (.1)	15 (T)	39 (T)	3 (T)	256 (.9)
05-72	5(.1)	45 (.1)	57 (.4)	34 (.2)	17 (T)	19 (T)	3 (T)	180 (.8)
08-72	16(.3)	14 (.1)	191 (.5)	24 (.3)	19 (T)	16 (T)	4 (T)	284(1.2)
08-72	22(.5)	31 (.4)	161(1.2)	22 (.1)	17(.1)	17 (T)	5 (T)	275(2.3)
08-72	6(.2)	6 (T)	39 (.5)	26 (.1)	3 (T)	16 (T)	4 (T)	100 (.8)
02-73	75(.2)	109(1.0)	328 (.5)	91 (.1)	9 (T)	28 (T)	0	640(1.8)
02-73	34(1.7)	144 (.6)	229 (.3)	29 (T)	22 (T)	20 (T)	1 (T)	479(2.6)
02-73	108(.4)	130 (.8)	623(1.2)	63 (.2)	12 (T)	83 (T)	1 (T)	1020(2.6)
05-73	23(.1)	100 (.3)	257 (.5)	100(1.4)	13 (T)	29 (T)	3 (T)	525(2.3)
05-73	5(.3)	67 (.1)	60 (.2)	40 (.2)	7 (T)	23 (T)	6 (T)	208 (.8)
05-73	12 (T)	53 (.1)	66 (.2)	32 (.9)	4 (T)	28 (T)	0	195(1.2)
08-73	26(.3)	26 (.2)	180(2.5)	74 (.2)	4 (T)	99(.1)	22(.1)	431(3.4)
08-73	9(.2)	9 (.1)	147 (.4)	17 (.1)	5 (T)	37 (T)	5 (T)	229 (.8)
08-73	12 (T)	32 (.4)	264 (.7)	33 (.1)	10(.1)	14 (T)	2 (T)	367(1.3)
10-73	52(.4)	185(1.1)	247 (.1)	36 (.2)	29 (T)	68 (T)	4 (T)	621(1.8)
10-73	15(.1)	68 (.3)	98 (.1)	8 (.6)	4 (T)	17 (T)	0	210(1.1)
10-73	51(.3)	100(1.1)	201 (.2)	28 (.2)	36(.1)	2 (T)	2 (T)	420(1.9)
05-74	2 (T)	39 (.7)	120 (.4)	12 (.1)	7 (T)	7 (T)	2 (T)	189(1.2)
05-74	4(.5)	67 (.5)	103 (.2)	7 (T)	3 (T)	11 (T)	1 (T)	196(1.2)
05-74	7 (T)	60 (.6)	119 (.3)	41 (.1)	6 (T)	6 (T)	0	239(1.0)
07-74	7 (T)	6 (T)	111 (.6)	26 (.2)	11 (T)	13 (T)	3 (T)	177 (.8)
07-74	0	2 (T)	28 (.2)	8 (T)	1 (T)	30 (T)	0	69 (.2)
07-74	27(.2)	6 (.1)	114 (.4)	38 (T)	12 (T)	1 (T)	6 (T)	204 (.7)
10-74	61(.4)	146 (.9)	519 (.7)	58 (.4)	13(.1)	26 (T)	7 (T)	830(2.5)
10-74	37(.3)	98 (.4)	301 (.3)	9 (T)	0	2 (T)	1 (T)	448(1.0)
10-74	45(.5)	225(1.5)	519 (.7)	69 (.1)	14 (T)	39 (T)	12 (T)	923(2.8)

a/ Mostly made up of Turbellaria, Nematoda and Hydracarina.

b/ Trace.

APPENDIX R. Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
STILLWATER RIVER - STATION 005								
03-70	43	18	74	168	4	2	0	309
04-71	15(.1)	9(.1)	163(.2)	5 (T)	1 (T)	0	10 (T)[b]	203 (.4)
10-71	30(.1)	14(.3)	85(.1)	22 (T)	2 (T)	27 (T)	0	180 (.5)
10-71	24(.1)	22(.3)	84(.1)	40 (T)	3 (T)	39 (T)	0	212 (.5)
10-71	5 (T)	5 (T)	48(.1)	3 (T)	1 (T)	5 (T)	0	67 (.1)
02-72	61(.2)	14(.2)	329(.5)	7 (T)	1 (T)	0	1 (T)	413 (.9)
02-72	39(.1)	11(.2)	344(.7)	5(.1)	0	1 (T)	0	400(1.1)
02-72	39(.5)	6 (T)	215(.3)	7 (T)	1 (T)	0	2 (T)	300 (.8)
05-72	0	0	108(.4)	1 (T)	0	0	0	109 (.4)
05-72	14(.3)	1 (T)	154(.6)	10(.1)	0	0	0	179(1.0)
05-72	12(.1)	2(.1)	97(.5)	7(.1)	3 (T)	41 (T)	0	162 (.8)
08-72	5 (T)	1 (T)	14 (T)	12 (T)	0	0	0	32 (T)
08-72	10 (T)	0	12 (T)	16 (T)	1 (T)	0	0	39 (T)
08-72	5(.1)	6 (T)	24(.1)	19 (T)	0	0	0	54 (.2)
02-73	19(.3)	2 (T)	360(.5)	8 (T)	1 (T)	0	1 (T)	391 (.8)
02-73	30(.1)	5 (T)	403(.4)	11(.1)	2 (T)	0	0	451 (.6)
02-73	47(.2)	26(.3)	366(.7)	29 (T)	0	0	3 (T)	471(1.2)
05-73	4 (T)	5 (T)	33(.1)	10(.1)	0	0	0	52 (.2)
05-73	7(.1)	2 (T)	114(.3)	68 (T)	2 (T)	0	1 (T)	194 (.9)
05-73	7 (T)	2 (T)	72(.4)	23(.2)	3 (T)	0	0	107 (.6)
07-73	9(.1)	12(.1)	61(.2)	21(.2)	5 (T)	0	3 (T)	111 (.6)
07-73	11 (T)	7(.1)	38(.1)	25 (T)	4 (T)	0	0	85 (.2)
07-73	26 (T)	5 (T)	31(.1)	54(.1)	4 (T)	0	0	120 (.2)
10-73	51(.4)	48(.4)	94(.2)	852(1.6)	0	0	21(.1)	1065(2.7)
10-73	61(.2)	45(.5)	141(.1)	26(.1)	2 (T)	10 (T)	2 (T)	283 (.9)
10-73	86(.2)	0	132(.1)	37(.1)	3 (T)	0	1 (T)	259 (.4)
02-74	38(.4)	28(.3)	158(.2)	15(.1)	0	1 (T)	2 (T)	242(1.0)
02-74	61(.7)	36(.3)	579(1.1)	49(.1)	0	5 (T)	3 (T)	733(2.2)
02-74	19 (T)	14 (T)	213(.5)	38(.1)	1 (T)	0	1 (T)	286 (.6)
05-74	114(.2)	13(.1)	270(.3)	162(.1)	6 (T)	64 (T)	15 (T)	644 (.7)
05-74	16(.3)	7(.2)	136(.6)	22(.1)	0	0	7 (T)	188(1.2)
05-74	0	3 (T)	48(.2)	11 (T)	2 (T)	0	0	64 (.2)
07-74	42(.3)	12(.6)	105(.1)	18(.1)	0	0	1 (T)	178(1.1)
07-74	7 (T)	5 (T)	96(.3)	4 (T)	0	1 (T)	0	113 (.3)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
STILLWATER RIVER - STATION 005								
07-74	18(.1)	9(.4)	113(.2)	17 (T)	2 (T)	6 (T)	3 (T)	168 (.7)
10-74	34(.1)	8(.2)	162(.2)	28(.1)	1 (T)	1 (T)	4 (T)	238 (.6)
10-74	12 (T)	1 (T)	18 (T)	11 (T)	0	1 (T)	3 (T)	46 (T)
10-74	36(.1)	9(.2)	101(.1)	31 (T)	2 (T)	1 (T)	1 (T)	181 (.4)
STILLWATER RIVER - STATION 006								
08-70	11	4	145	41	2	0	0	203
04-71	92(.4)	83(.3)	300(.1)	65 (T)	0	0	0	540 (.8)
10-71	30(.3)	52(.6)	254(.3)	63(.2)	0	1 (T)	0	400(1.4)
10-71	10(.1)	2(.4)	135(.3)	8(.4)	0	4 (T)	0	159(1.2)
10-71	19(.1)	12(.3)	71(.2)	5(.1)	0	0	0	107 (.7)
02-72	126(.3)	51(.9)	409(.9)	105(.1)	1 (T)	23 (T)	1 (T)	716(2.2)
02-72	29 (T)	26(.2)	339(.8)	41(.1)	0	2 (T)	1 (T)	438(1.1)
02-72	100(.6)	39(.4)	456(.8)	45 (T)	0	7 (T)	1 (T)	648(1.8)
05-72	41(.7)	5 (T)	152(.2)	29(.2)	0	2 (T)	0	229(1.1)
05-72	17(.2)	0	84(.3)	13 (T)	0	27 (T)	0	141 (.5)
05-72	14(.1)	1 (T)	98(.2)	6 (T)	0	6 (T)	0	125 (.3)
08-72	13(.2)	4 (T)	86(.1)	28(.2)	1 (T)	9 (T)	1 (T)	142 (.5)
08-72	19 (T)	3(.1)	110(.2)	17 (T)	2 (T)	15 (T)	1 (T)	167 (.3)
08-72	3 (T)	0	70(.2)	10(.1)	0	0	0	83 (.3)
02-73	55(.2)	17(.1)	195(.2)	28 (T)	1 (T)	0	1 (T)	297 (.5)
02-73	130(.9)	97(.9)	461(.9)	120(.4)	0	23 (T)	1 (T)	832(2.7)
02-73	47(.1)	35(.5)	241(.8)	20 (T)	1 (T)	0	1 (T)	345(1.4)
05-73	19(.1)	22(.3)	399(.8)	26(.4)	1 (T)	41 (T)	1 (T)	509(1.6)
05-73	21(.2)	38(.7)	221(.7)	21(.1)	0	11 (T)	1 (T)	313(1.7)
05-73	28(.1)	4(.1)	129(.2)	15 (T)	1 (T)	2 (T)	0	179 (.4)
07-73	31 (T)	13(.5)	178(.2)	29(.1)	1 (T)	0	1 (T)	253 (.8)
07-73	13 (T)	27(1.0)	201(.5)	35 (T)	1 (T)	0	1 (T)	278(1.5)
07-73	35(.1)	37(1.5)	147(.5)	45(.2)	0	13 (T)	2 (T)	279(2.3)
10-73	13(.2)	15(.2)	125(.1)	11(.4)	1 (T)	1 (T)	0	166 (.9)
10-73	88(.4)	49(.8)	331(.2)	37(.2)	0	6 (T)	1 (T)	512(1.6)
10-73	24(.1)	18(.2)	132(.2)	6 (T)	0	0	2 (T)	182 (.5)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
STILLWATER RIVER - STATION 006								
02-74	186(.5)	98(1.1)	726(1.0)	188(.2)	2 (T)	20 (T)	2 (T)	1222(2.8)
02-74	102(.3)	96(1.3)	383(.7)	168(.4)	0	2 (T)	0	751(2.7)
02-74	41(.2)	20(.1)	376(.7)	21(.1)	1 (T)	46 (T)	0	505(1.1)
05-74	19(.3)	13(.8)	111(.7)	7(.3)	1 (T)	2 (T)	0	153(2.1)
05-74	13(.8)	25(.5)	109(.5)	12(.1)	1 (T)	3 (T)	1 (T)	164(1.9)
05-74	21(.1)	24(.3)	268(.4)	20(.6)	1 (T)	5 (T)	0	339(1.4)
07-74	12 (T)	4(.1)	61(.3)	3 (T)	0	0	0	80 (.4)
07-74	10 (T)	5(.1)	66(.2)	6 (T)	0	0	0	87 (.3)
07-74	13 (T)	1 (T)	49(.1)	0	0	0	0	63 (.1)
10-74	113(.4)	11(.4)	219(.2)	5 (T)	0	47 (T)	1 (T)	396 (.7)
10-74	75(.1)	30(.4)	368(.7)	12(.3)	1 (T)	86 (T)	4 (T)	576(1.5)
10-74	7 (T)	5 (T)	108(.2)	6(.2)	0	0	0	126 (.4)
STILLWATER RIVER - STATION 032								
04-71	31(.1)	131(1.5)	505(.7)	120(.1)	3(.1)	0	0	790(2.5)
10-71	30(.2)	13(.1)	89(.2)	13(.1)	2 (T)	0	0	147 (.6)
10-71	20(.1)	15(.1)	57(.3)	20(.1)	2 (T)	3 (T)	2 (T)	119 (.6)
10-71	24 (T)	4 (T)	61(.2)	1 (T)	0	0	0	90 (.2)
02-72	30(.2)	58(.3)	225(.8)	47(.3)	4 (T)	24 (T)	0	388(1.6)
02-72	44(.1)	86(.8)	201(1.0)	32(.3)	0	25 (T)	0	388(2.2)
02-72	32(.1)	18(.1)	125(.5)	28(.1)	3 (T)	46 (T)	0	252 (.8)
05-72	18(.2)	3 (T)	161(.4)	5 (T)	0	0	0	187 (.6)
05-72	14(.1)	5(.1)	139(.3)	4 (T)	0	2 (T)	0	164 (.5)
05-72	24(.3)	9(.1)	223(.5)	5 (T)	0	0	0	261 (.9)
08-72	32(.1)	3 (T)	206(.3)	32 (T)	0	0	0	273 (.4)
08-72	38 (T)	0	111(.1)	21 (T)	0	0	0	170 (.1)
08-72	13(.1)	3 (T)	120(.2)	21 (T)	1 (T)	0	0	158 (.3)
02-73	14(.1)	80(.5)	81(.5)	64(.3)	3 (T)	19 (T)	0	261(1.4)
02-73	36(.4)	107(.4)	140(.8)	80(.3)	2 (T)	33 (T)	4 (T)	402(1.9)
02-73	103(.2)	94(.2)	180(.9)	78(.4)	4 (T)	133 (T)	1 (T)	593(1.7)
05-73	71(.5)	116(.8)	181(.8)	54(.4)	7 (T)	34 (T)	1 (T)	464(2.5)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
STILLWATER RIVER - STATION 032								
05-73	32(.1)	10(.1)	345(1.0)	93(.1)	1 (T)	7 (T)	1 (T)	489(1.3)
05-73	37(.3)	45(.2)	546(.7)	50(.6)	21(.1)	163 (T)	6 (T)	868(1.9)
07-73	27 (T)	13(.6)	204(.2)	58 (T)	3 (T)	2 (T)	0	307 (.8)
07-73	17(.4)	3 (T)	102(.2)	54(.1)	0	0	2 (T)	178 (.7)
07-73	12(.1)	9(.1)	75(.1)	32 (T)	1 (T)	6 (T)	1 (T)	136 (.3)
10-73	61(.1)	135(.6)	183(.4)	34(.3)	5 (T)	5 (T)	1 (T)	424(1.4)
10-73	84(.2)	194(1.3)	135(.3)	51(.3)	4 (T)	3 (T)	0	471(2.1)
10-73	214(.8)	198(1.1)	411(.8)	60(.5)	14 (T)	8 (T)	10 (T)	915(3.2)
02-74	84(.3)	232(3.2)	269(.9)	47(.7)	2 (T)	70 (T)	1 (T)	705(5.1)
02-74	42(.2)	136(1.5)	102(.5)	47(.8)	3 (T)	9 (T)	5 (T)	344(3.0)
02-74	49(.4)	72(.6)	129(.5)	29(.3)	1 (T)	16 (T)	6 (T)	302(1.8)
05-74	44(.2)	32(.3)	275(.6)	36(.1)	0	10 (T)	4 (T)	401(1.2)
05-74	3 (T)	9(.1)	146(.2)	18(.2)	1 (T)	0	1 (T)	178 (.5)
05-74	35(.1)	12(.1)	171(.3)	27(.1)	3 (T)	9 (T)	1 (T)	258 (.6)
07-74	14(.1)	1 (T)	68(.2)	3 (T)	0	0	0	86 (.3)
07-74	28(.1)	0	79(.4)	5 (T)	0	0	0	112 (.5)
07-74	50(.1)	7(.2)	241(.6)	19 (T)	1 (T)	1 (T)	0	319 (.9)
10-74	45(.1)	25(.2)	298(.3)	20(.4)	11(.1)	10 (T)	0	409(1.1)
10-74	36(.1)	16(.2)	316(.4)	19 (T)	0	46 (T)	1 (T)	434 (.7)
10-74	26(.2)	9(.2)	380(.5)	21(.2)	3 (T)	27 (T)	2 (T)	468(1.1)
STILLWATER RIVER - STATION 033								
08-70	47	31	163	26	3	3	2	275
04-71	25(.1)	101(.9)	154(.6)	3 (T)	3(.1)	18(.5)	0	304(2.2)
10-71	91(.5)	105(1.1)	388(1.3)	64(.3)	1 (T)	2 (T)	0	651(3.2)
10-71	67(.2)	179(1.0)	197(.7)	39(.6)	1 (T)	8 (T)	0	491(2.5)
10-71	57(.3)	91(1.0)	177(.9)	229(.5)	4 (T)	23 (T)	1 (T)	582(2.7)
02-72	89(.5)	156(1.8)	401(.9)	185(.4)	18(.1)	70 (T)	2 (T)	921(3.7)
02-72	93(1.1)	125 (.8)	465(1.5)	99(.4)	5 (T)	114(.1)	2 (T)	903(3.9)
02-72	68(.7)	122 (.7)	297(2.2)	65(.3)	3 (T)	54 (T)	1 (T)	610(3.9)
05-72	34(.2)	25 (.1)	215(1.0)	11(.1)	2 (T)	2 (T)	0	289(1.4)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
STILLWATER RIVER STATION 033								
05-72	13(.5)	6(.2)	105(.7)	3(.1)	2 (T)	0	0	129(1.5)
05-72	24(.2)	17(.3)	82(.5)	14 (T)	0	72 (T)	0	209(1.0)
08-72	57(.1)	6 (T)	188(.2)	35 (T)	9 (T)	4 (T)	1 (T)	300 (.3)
08-72	73 (T)	2 (T)	180(.3)	37(.2)	30 (T)	9 (T)	0	331 (.5)
08-72	37(.4)	4 (T)	253(.5)	25(.2)	2 (T)	0	0	321(1.1)
02-73	141(2.8)	158(1.6)	225(1.8)	323(.2)	3 (T)	35 (T)	3 (T)	888(6.4)
02-73	124(.7)	143(1.0)	204(1.1)	100(1.0)	8 (T)	118 (T)	7 (T)	704(3.8)
02-73	48(1.5)	70(1.0)	203(1.4)	134(.4)	5 (T)	62 (T)	3 (T)	525(4.3)
05-73	37(1.5)	81(1.7)	122(1.4)	38(.2)	1 (T)	0	2 (T)	281(4.8)
05-73	15(.1)	30(.1)	80(.8)	65(.5)	14 (T)	0	2 (T)	206(1.6)
05-73	20 (T)	29(.5)	271(.5)	123(.8)	9 (T)	59 (T)	2 (T)	513(1.8)
08-73	61(.1)	25(.1)	202(.5)	35(.1)	4 (T)	12 (T)	6 (T)	345 (.8)
08-73	71(.1)	5 (T)	80(.2)	57(.1)	2 (T)	37 (T)	5 (T)	257 (.4)
08-73	14 (T)	3 (T)	108(.2)	5(.2)	3 (T)	4 (T)	3 (T)	140 (.4)
10-73	39(.5)	63(.2)	134(.2)	337(.3)	6 (T)	24 (T)	3 (T)	606(1.2)
10-73	66(.2)	141(1.1)	290(.6)	378(.6)	4 (T)	94(.1)	10 (T)	983(2.6)
10-73	107(.4)	150(.8)	374(1.0)	374(1.0)	4 (T)	37 (T)	4 (T)	1050(3.2)
02-74	77(.3)	103(.5)	319(1.3)	30(.7)	2 (T)	51 (T)	4 (T)	586(2.8)
02-74	65(.2)	28(.1)	162(.8)	11(.2)	0	6 (T)	0	272(1.3)
02-74	236(1.5)	111(.8)	396(1.9)	33(.7)	1 (T)	91 (T)	0	868(4.9)
05-74	52(.3)	211(2.5)	801(2.3)	89(.4)	8 (T)	106 (T)	5 (T)	1272(5.5)
05-74	63(1.0)	160(2.3)	461(1.2)	69(.4)	5 (T)	30 (T)	2 (T)	790(4.9)
05-74	88(.5)	158(3.2)	457(2.0)	94(.5)	3 (T)	34 (T)	1 (T)	835(6.2)
07-74	16(.2)	6(.1)	86(.6)	23(.1)	1 (T)	0	0	132(1.0)
07-74	31(.2)	10(.1)	103(.5)	15(.2)	2 (T)	10 (T)	0	171(1.0)
07-74	40(.7)	11(.1)	128(.9)	28(.2)	0	61 (T)	1 (T)	269(1.9)
10-74	60(.2)	17(.1)	349(.8)	47(.6)	2 (T)	12 (T)	1 (T)	488(1.7)
10-74	101(.1)	43(.3)	220(.5)	27(.1)	0	0	4 (T)	395(1.0)
10-74	89(.1)	23(.1)	264(.5)	89(.5)	3 (T)	18 (T)	2 (T)	488(1.2)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
STILLWATER RIVER - STATION 034								
08-70	21	41	159	30	7	0	0	258
04-71	45(.3)	198(.7)	577(1.0)	48(.2)	10 (T)	0	0	878(2.2)
10-71	41(.6)	51(.2)	112(.8)	121(.4)	13 (T)	0	0	338(1.8)
10-71	47(1.6)	425(2.1)	191(.5)	46(.3)	9 (T)	67 (T)	0	785(4.5)
10-71	36(1.5)	197(3.3)	151(.7)	101(.4)	19 (T)	0	9 (T)	513(5.9)
02-72	156(.6)	216(.6)	320(1.3)	228(.7)	7 (T)	84 (T)	16(.1)	1027(3.3)
02-72	66(.6)	168(.7)	210(.3)	142(.5)	6 (T)	22 (T)	0	614(2.1)
02-72	112(.7)	276(1.0)	238(.6)	167(.4)	10(.1)	98 (T)	4 (T)	905(2.8)
05-72	15(.1)	2 (T)	188(1.2)	4 (T)	0	2 (T)	0	211(1.3)
05-72	12 (T)	1 (T)	345(1.7)	135(.1)	1 (T)	7 (T)	0	501(1.8)
05-72	16(.1)	3 (T)	108(.3)	20(.1)	1 (T)	10 (T)	0	158 (.5)
08-72	61(.2)	103(.2)	348(.5)	75(.3)	10 (T)	32 (T)	5 (T)	634(1.2)
08-72	43(.1)	45(.1)	293(.3)	74(.3)	7 (T)	33 (T)	2 (T)	497 (.8)
08-72	21(.1)	34(.2)	112(.2)	22 (T)	5 (T)	0	0	194 (.5)
02-73	185(1.5)	234(1.9)	325(1.6)	163(1.3)	3 (T)	167 (T)	1 (T)	1081(6.3)
02-73	28(.7)	95(.7)	169(.8)	108(.3)	11 (T)	68 (T)	4 (T)	483(2.5)
02-73	26(1.5)	56(.3)	171(1.1)	69(.5)	5 (T)	57 (T)	2 (T)	386(3.4)
05-73	51(.4)	156(.5)	465(1.7)	305(.7)	9 (T)	0	2 (T)	988(3.3)
05-73	28(.5)	45(.3)	482(.5)	339(1.3)	43(.1)	32 (T)	0	969(2.7)
05-73	60(1.8)	171(1.2)	258(.4)	336(.9)	33 (T)	0	14 (T)	872(4.3)
08-73	66(.2)	37(.1)	199(.4)	60(.3)	16 (T)	109 (T)	9 (T)	496(1.0)
08-73	17 (T)	28(.1)	95(.2)	95(.3)	11 (T)	10 (T)	8 (T)	264 (.6)
08-73	48(.1)	38(.1)	257(.4)	58(.2)	24 (T)	23 (T)	2 (T)	450 (.8)
10-73	43(.1)	84(.3)	110(.2)	46(.3)	1 (T)	6 (T)	1 (T)	291 (.9)
10-73	47(1.6)	330(2.4)	133(.3)	95(.4)	3 (T)	8 (T)	4 (T)	620(4.7)
10-73	86(.2)	266(1.2)	163(.4)	98(.5)	13 (T)	83 (T)	13 (T)	722(2.3)
02-74	64(.5)	213(1.0)	167(.6)	54(.8)	5 (T)	39 (T)	5 (T)	547(2.9)
02-74	64(.7)	62(.1)	329(.6)	98(.2)	10 (T)	56 (T)	7 (T)	626(1.6)
02-74	73(.4)	182(.9)	221(1.1)	60(.3)	4 (T)	31 (T)	16 (T)	587(2.7)
05-74	68(.6)	293(1.1)	482(.8)	197(1.2)	48 (T)	119 (T)	25(.1)	1232(3.8)
05-74	49(1.3)	126(.5)	470(.8)	105(.3)	16 (T)	128(.1)	26(.1)	920(3.1)
05-74	16(.2)	111(.4)	304(.5)	40(.3)	7 (T)	11 (T)	3 (T)	492(1.4)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
STILLWATER RIVER - STATION 034								
07-74	9 (T)	19(.2)	30(.2)	6 (T)	2 (T)	0	0	66 (.4)
07-74	27(.1)	9(.1)	59(.7)	3 (T)	0	0	1 (T)	99 (.9)
07-74	27(.1)	24(.2)	186(.4)	41(.1)	6 (T)	0	1 (T)	285 (.8)
10-74	65(.6)	37(.1)	254(.3)	111(.6)	7 (T)	24 (T)	5 (T)	503(1.6)
10-74	92(.3)	76 (T)	154(.2)	39(.2)	2 (T)	5 (T)	2 (T)	370 (.7)
10-74	91(.4)	85(.4)	142(.3)	39(.4)	3 (T)	14 (T)	0	374(1.5)
STILLWATER RIVER - STATION 035								
08-70	29	74	64	324	1	2	0	494
10-71	41(.4)	524(8.8)	156(.2)	28 (T)	19 (T)	0	29 (T)	797(9.4)
10-71	39(.2)	533(9.1)	109(.5)	42(.3)	24 (T)	0	20 (T)	767(10.1)
10-71	32(.1)	242(3.1)	205(.4)	60(.6)	14 (T)	0	30 (T)	583(4.2)
02-72	51(.5)	190(1.3)	119(.8)	13(.2)	17 (T)	18 (T)	1 (T)	409(2.8)
02-72	22(.4)	82(.7)	112(.3)	10 (T)	5 (T)	9 (T)	0	240(1.4)
02-72	26(.7)	248(1.7)	162(.2)	31(.5)	19(.1)	41 (T)	2 (T)	529(2.7)
05-72	3(.1)	3 (T)	9(.1)	30(.1)	0	1 (T)	0	46 (.3)
05-72	2 (T)	0	4(.1)	35(.1)	0	7 (T)	0	48 (.2)
05-72	7 (T)	28(.2)	106(.7)	258(1.1)	10 (T)	7 (T)	1[c]	417(2.0)
08-72	7 (T)	80(.3)	50(.2)	137(.1)	0	0	0	274 (.6)
08-72	5 (T)	174(1.2)	41(.2)	136(.1)	6 (T)	0	3 (T)	365(1.5)
08-72	5 (T)	38(.1)	81(.3)	110(.1)	5 (T)	0	1 (T)	240 (.5)
02-73	42(.7)	338(2.8)	328(.5)	117(.6)	15 (T)	40 (T)	0	880(4.6)
02-73	26(.6)	345(3.8)	500(.8)	165(.5)	9 (T)	28 (T)	1 (T)	1074(5.7)
02-73	66(1.5)	499(5.7)	421(.7)	156(1.0)	31(.1)	59 (T)	1 (T)	1233(9.0)
05-73	21(.6)	94(1.1)	184(.5)	190(.2)	5(.1)	0	0	494(2.5)
05-73	14 (T)	20(.1)	110(.4)	90(.1)	3 (T)	0	0	237 (.6)
05-73	16(.1)	35(.2)	149(.6)	96(1.8)	6 (T)	1 (T)	1 (T)	304(2.7)
08-73	14(.1)	21(.1)	96(.1)	559(.8)	19 (T)	0	1 (T)	710(1.1)
08-73	11(.1)	38(.3)	103(.2)	213(.4)	4 (T)	0	3 (T)	372(1.0)
08-73	9 (T)	34(.1)	105(.3)	326(.4)	10 (T)	0	0	484 (.8)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
STILLWATER RIVER - STATION 035								
10-73	57(.4)	491(5.6)	112(.2)	50(.5)	13(T)	0	2 (T)	725(6.7)
10-73	58(.1)	214(1.0)	141(.3)	19(.2)	7(T)	6 (T)	3 (T)	448(1.6)
10-73	61(.4)	220(1.3)	160(.5)	55(.5)	12(T)	1 (T)	4 (T)	513(2.7)
02-74	28(.3)	281(2.4)	212(.9)	37(.1)	10(T)	0	2 (T)	570(3.7)
02-74	44(.5)	442(4.4)	175(.3)	58(.2)	9(T)	1 (T)	1 (T)	730(5.4)
02-74	54(.2)	137(.4)	221(1.4)	34(1.0)	3(T)	3 (T)	1 (T)	453(3.0)
05-74	57(.7)	320(1.4)	386(1.6)	75(.1)	21(T)	13 (T)	8(.2)	880(4.0)
05-74	7(.1)	241(1.1)	195(.6)	55(.9)	12(T)	8 (T)	3 (T)	521(2.7)
05-74	11(.2)	208(1.4)	151(.6)	63(.1)	12(T)	5 (T)	2 (T)	452(2.3)
07-74	2 (T)	14(.2)	28(.1)	27(.2)	0	0	1 (T)	72 (.5)
07-74	3 (T)	7 (T)	28(.1)	28(.1)	8(T)	1(.1)	0	75 (.3)
07-74	5(.3)	25(.8)	21(.1)	19(.2)	2(T)	0	0	72(1.4)
10-74	15 (T)	54(.5)	79(.1)	22(.2)	5(T)	2 (T)	0	177 (.8)
10-74	51(.3)	182(.6)	395(.4)	48(.1)	50(T)	51 (T)	4 (T)	781(1.4)
10-74	48(.8)	107(.4)	210(.1)	28(.1)	10(T)	29 (T)	0	432(1.4)
VERDIGRIS CREEK - STATION 043								
08-72	0	0	0	1 (T)	0	0	0	1 (T)
08-72	0	2 (T)	0	1 (T)	0	0	0	3 (T)
08-72	1 (T)	0	0	0	0	0	0	1 (T)
VERDIGRIS CREEK - STATION 055								
07-74	2 (T)	0	3 (T)	2 (T)	0	2 (T)	2 (T)	11 (T)
07-74	9 (T)	15(.2)	61(.1)	19 (T)	0	118(.1)	8 (T)	230(.4)
07-74	4 (T)	10(.1)	17(.1)	0	0	3 (T)	4 (T)	38(.2)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
MOUNTAIN VIEW CREEK - STATION 044								
08-72	3 (T)	7(.2)	23(.1)	16 (T)	2 (T)	4(.1)	0	55(.4)
08-72	21 (T)	6 (T)	27(.1)	4 (T)	0	0	0	58(.1)
08-72	10 (T)	5(.2)	27 (T)	2 (T)	0	0	0	44(.2)
07-73	0	10(.2)	30(.3)	10 (T)	0	0	1 (T)	51(.5)
07-73	10 (T)	9(.2)	46(.3)	1 (T)	1 (T)	0	0	67(.5)
07-73	9 (T)	14 (T)	26(.1)	10 (T)	0	2 (T)	0	61(.1)
07-74	19 (T)	21(.4)	26(.2)	9 (T)	2(.1)	8(.3)	2 (T)	87(1.0)
07-74	1 (T)	5 (T)	13(.1)	21(.1)	0	3 (T)	2 (T)	45(.2)
07-74	18 (T)	11 (T)	56(.2)	14 (T)	0	4(.1)	3 (T)	106(.3)
NYE CREEK - STATION 016								
08-72	4 (T)	2 (T)	6 (T)	24 (T)	1 (T)	5 (T)	1 (T)	43 (T)
08-72	0	1 (T)	8 (T)	8 (T)	1 (T)	0	2 (T)	20 (T)
08-72	0	1 (T)	3 (T)	0	0	0	3 (T)	7 (T)
07-73	0	12(.2)	66(.1)	12 (T)	0	0	5 (T)	95(.3)
07-73	0	0	14 (T)	5 (T)	0	0	2 (T)	21 (T)
07-73	1 (T)	4 (T)	34(.1)	4 (T)	0	0	8 (T)	51(.1)
07-74	0	4 (T)	17 (T)	7(.1)	0	2 (T)	0	30(.1)
07-74	1 (T)	12(.1)	18 (T)	14 (T)	0	1 (T)	5 (T)	51(.1)
07-74	0	11 (T)	8 (T)	4 (T)	1 (T)	0	0	24 (T)
SILVER CREEK - STATION 042								
08-72	0	1 (T)	8 (T)	1 (T)	5 (T)	1(.1)	2 (T)	18(.1)
08-72	15(.1)	16(.1)	134(.2)	28(.1)	37 (T)	2 (T)	2 (T)	234(.5)
08-72	5 (T)	15(.1)	132(.3)	7(.1)	17 (T)	3(.1)	4 (T)	183(.6)
07-73	10 (T)	7(.1)	58(.1)	26 (T)	100 (T)	1(.1)	0	202(.3)
07-73	24(.1)	23(.1)	60(.1)	34 (T)	82 (T)	4(.1)	0	227(.4)
07-73	30 (T)	34(.1)	168(.1)	86(.8)	99 (T)	5(.3)	1(.8)	423(2.1)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
LITTLE ROCKY CREEK - STATION 015								
08-72	41(.1)	60(.7)	129(.5)	22(.1)	2 (T)	167(.1)	14(.1)	435(1.6)
08-72	17(.1)	11(.1)	47(.4)	3 (T)	4 (T)	10 (T)	0	92 (.6)
08-72	62(.1)	27(.1)	74(.4)	10 (T)	6 (T)	127 (T)	4 (T)	310 (.6)
07-73	26 (T)	29(.4)	42(1.1)	0	7 (T)	32 (T)	7 (T)	143(1.5)
07-73	29 (T)	20(.2)	29(1.3)	1 (T)	4 (T)	29 (T)	4(.1)	116(1.6)
07-73	59(.1)	52(.8)	53(.5)	21 (T)	5 (T)	58 (T)	11 (T)	259(1.4)
07-74	23(.2)	22(.1)	19(.1)	7 (T)	3 (T)	1 (T)	4 (T)	79 (.4)
07-74	50 (T)	34(.3)	67(.4)	6 (T)	1 (T)	2 (T)	7 (T)	167 (.7)
07-74	23(.2)	29(.3)	49(.6)	3 (T)	6 (T)	5 (T)	4 (T)	119(1.1)
LITTLE ROCKY CREEK - STATION 031								
10-71	34 (T)	4 (T)	71(.1)	72(1.1)	12 (T)	3 (T)	0	196(1.2)
10-71	14 (T)	1 (T)	19(.1)	20(2.1)	7 (T)	2 (T)	0	63(2.2)
10-71	38(.1)	15(.1)	85(.1)	59(1.3)	11(.1)	2 (T)	0	210(1.7)
02-72	17(.3)	51 (T)	119(.3)	322(1.9)	40 (T)	1 (T)	52(.1)	602(2.6)
02-72	26 (T)	78(.1)	126(.2)	424(3.5)	103(.1)	0	26 (T)	783(3.9)
02-72	8 (T)	78(.1)	113(.2)	826(.4)	80 (T)	0	31 (T)	1140 (.7)
05-72	1 (T)	67(.4)	92(.5)	247(4.3)	22(.1)	1 (T)	16 (T)	446(5.3)
05-72	5(.1)	103(.3)	60(.1)	164(.5)	12 (T)	2 (T)	14(.1)	360(1.1)
05-72	5(.1)	65(.3)	117(.7)	170(1.5)	7 (T)	6 (T)	18(.1)	388(2.7)
08-72	14 (T)	56(.6)	218(.5)	15(.1)	24 (T)	0	12(.1)	339(1.3)
08-72	8 (T)	46(.4)	89(.4)	9 (T)	2 (T)	0	1 (T)	155 (.8)
08-72	17 (T)	28(.2)	157(.2)	20 (T)	19(.1)	0	5 (T)	246 (.5)
02-73	28(.4)	101(.6)	113(.5)	171(.4)	48(.1)	0	40(.1)	501(2.1)
02-73	16(.1)	93(.5)	51(.3)	172(1.0)	65(.1)	6 (T)	28 (T)	431(2.0)
02-73	44(.1)	62(.1)	148(.2)	432(2.3)	46 (T)	0	31 (T)	763(2.7)
05-73	8 (T)	44(.2)	130(.7)	50(.2)	27 (T)	0	24 (T)	283(1.1)
05-73	4 (T)	101(.5)	137(.3)	77(2.8)	18 (T)	0	14 (T)	351(3.6)
05-73	4 (T)	81(.5)	71(.4)	130(.5)	37 (T)	0	15 (T)	338(1.4)
07-73	20 (T)	78(.3)	153(.5)	44(.1)	32 (T)	0	4 (T)	331 (.9)
07-73	4 (T)	21(.2)	62(.1)	15 (T)	13 (T)	0	8 (T)	123 (.3)
07-73	7 (T)	30(.2)	196(.2)	74(.1)	45 (T)	0	12(.1)	364 (.6)

APPENDIX R. continued ( ). Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Stillwater River drainage.

DATE	PLECOPTERA	TRICHOPTERA	EPHEMEROPTERA	DIPTERA	COLEOPTERA	ANNELIDA	OTHER[a]	TOTAL
LITTLE ROCKY CREEK - STATION 031								
10-73	21 (T)	157(.8)	86(.2)	168(.3)	148(.1)	6 (T)	18(.1)	604(1.5)
10-73	67(.8)	129(.2)	52(.1)	85(.1)	41(.1)	3 (T)	11 (T)	388(1.3)
10-73	54(.1)	233(.6)	132(.1)	176(.7)	83(.1)	2 (T)	20 (T)	700(1.6)
02-74	17(.1)	108(.4)	75(.3)	106(.4)	18 (T)	0	9 (T)	333(1.2)
02-74	25(.3)	77(.4)	76(.1)	55(.1)	5 (T)	0	4 (T)	242 (.9)
02-74	5 (T)	63(.2)	22(.2)	121(.2)	14 (T)	0	6 (T)	231 (.6)
05-74	2 (T)	77(.5)	331(.5)	57(.1)	6 (T)	2 (T)	4 (T)	479(1.1)
05-74	6(.1)	85(.5)	209(.4)	49(.1)	9 (T)	1 (T)	9 (T)	368(1.1)
05-74	15(.2)	46(.2)	314(.5)	57(1.3)	13 (T)	0	6 (T)	451(2.3)
07-74	10 (T)	35(.2)	50(.7)	4 (T)	30 (T)	2 (T)	10 (T)	141 (.9)
07-74	12(.1)	26(.2)	49(1.4)	2 (T)	11 (T)	0	4 (T)	104(1.7)
07-74	16(.1)	24(.2)	52(1.3)	8 (T)	18 (T)	1 (T)	4 (T)	123(1.6)
10-74	39(.1)	48(.4)	172(.2)	64(.1)	66(.1)	0	1 (T)	390 (.9)
10-74	67(.2)	165(1.4)	140(.1)	35(.1)	26 (T)	1 (T)	48 (T)	482(1.8)
10-74	192(.3)	288(1.8)	545(.5)	214(.2)	72(.1)	0	12 (T)	1323(3.0)

a/ Mostly made up of Turbellaria, Nematoda and Hydracarina

b/ Trace

c/ Snail

Appendix S. Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the West Fork Stillwater River drainage.

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other[a]	Total
		West Fork Stillwater River - Station 054						
7-73	34(.1)	47(.1)	168(.3)	6(T)b	2(T)	158(T)	2(T)	417(.5)
7-73	54(T)	76(.3)	139(.5)	24(.1)	0	11(T)	1(T)	305(.9)
7-73	23(T)	33(.3)	69(.3)	7(T)	0	93(.1)	0	225(.7)
5-74	40(.3)	62(.5)	177(.8)	34(.2)	0	29(T)	6(T)	348(1.8)
5-74	22(.2)	40(.2)	114(.2)	14(.3)	0	39(T)	0	229(.9)
5-74	20(.1)	73(.4)	60(.1)	2(T)	0	13(T)	0	168(.6)
7-74	12(T)	17(.4)	44(.1)	6(.1)	0	0	0	79(.6)
7-74	7(T)	16(.1)	37(.2)	2(T)	0	0	0	62(.3)
7-74	3(T)	6(.1)	14(.1)	9(T)	0	0	1(T)	33(.2)
9-74	18(.1)	13(.1)	40(.1)	5(T)	0	0	0	76(.3)
9-74	20(T)	55(T)	140(.2)	9(.1)	0	73(T)	5(T)	302(.3)
9-74	51(.2)	24(.6)	93(.1)	9(T)	0	71(T)	2(T)	250(.9)
		West Fork Stillwater River - Station 070						
4-75	5(.1)	29(.2)	98(.2)	1(T)	0	0	3(T)	136(.5)
4-75	10(.1)	76(.6)	118(.3)	10(T)	0	0	0	214(1.0)
4-75	6(T)	8(T)	96(.5)	7(T)	0	0	2(T)	119(.5)
11-75	55	22	90	2	0	141	0	310
11-75	106	36	105	3	0	38	0	288
11-75	89	18	156	2	0	45	0	310
2-76	86(.2)	19(.1)	70(.2)	0	0	5(T)	7(T)	187(.5)
2-76	43(.3)	2(T)	101(.2)	8(T)	0	0	2(T)	156(.5)
2-76	84(.8)	6(T)	66(.4)	2(T)	0	0	2(T)	160(.2)
5-76	28	2	59	4	0	2	0	95
5-76	29	4	69	7	0	16	0	125
5-76	21	12	38	4	0	3	0	203
		West Fork Stillwater River - Station 037						
8-70	19	18	208	20	0	0	0	265
10-71	53(.1)	47(.1)	94(.4)	3(T)	0	24(T)	0	221(.6)
10-71	65(T)	35(.2)	137(.4)	3(T)	2(T)	39(T)	0	281(.6)
10-71	43(T)	28(.1)	74(.2)	7(.4)	1(T)	17(T)	0	170(.7)
5-72	1(T)	6(T)	6(.1)	1(T)	0	33(.1)	0	47(.2)
5-72	4(T)	3(T)	7(.1)	4(T)	0	46(T)	0	64(.1)
5-72	9(T)	11(.1)	48(.2)	19(.1)	0	140(.1)	1	228(.5)
8-72	24(T)	12(T)	66(.3)	5(.1)	0	67(T)	0	174(.4)
8-72	21(T)	6(T)	44(.2)	11(T)	0	50(T)	0	132(.2)
8-72	13(T)	6(T)	71(.2)	4(.1)	0	34(T)	0	128(.3)
5-73	11(.1)	23(.2)	86(.5)	4(T)	0	33(T)	5(T)	162(.8)
5-73	22(T)	36(.4)	215(1.4)	13(T)	0	13(T)	10(T)	309(1.8)
5-73	16(T)	29(.4)	161(1.2)	3(.1)	1(T)	48(T)	8(.1)	266(1.8)
7-73	64(.1)	3(T)	188(.4)	21(.2)	0	39(T)	1(T)	316(.7)
7-73	32(T)	7(T)	207(.4)	17(.4)	0	122(T)	1(T)	386(.8)
7-73	33(T)	10(.1)	181(.4)	14(.1)	1(T)	146(T)	2(T)	387(.6)
10-73	78(.1)	20(T)	125(.2)	4(T)	2(T)	13(T)	2(T)	244(.3)
10-73	41(.1)	28(.2)	104(.2)	11(T)	1(T)	15(T)	1(T)	201(.5)
10-73	16(T)	14(.2)	58(.1)	7(.3)	3(T)	1(T)	1(T)	100(.6)
5-74	49(T)	45(.6)	132(1.1)	19(T)	1(T)	10(T)	2(T)	258(1.7)
5-74	10(T)	98(.2)	117(.8)	15(.2)	0	5(T)	1(T)	246(1.2)
5-74	45(.1)	49(.3)	181(1.1)	22(.1)	2(T)	48(T)	7(T)	354(1.6)

a - Mostly made up of Turbellaria, Nematoda, and Hydracarina
b - Trace

Appendix S. Continued

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other[a]	Total
	West Fork Stillwater River - Station 037 continued							
7-74	5(T)	4(T)	39(.2)	2(T)	0	0	0	50(.2)
7-74	5(T)	27(.1)	39(.1)	1(T)	1(T)	2(T)	0	75(.2)
7-74	3(T)	1(T)	10(T)	2(T)	0	0	0	16(T)
10-74	35(.2)	36(.2)	87(.1)	10(.1)	2(T)	43(T)	3(T)	216(.6)
10-74	32(.1)	35(.2)	61(.1)	14(T)	0	31(T)	2(T)	175(.4)
10-74	20(T)	7(T)	83(.2)	16(.1)	0	16(T)	4(T)	146(.3)
4-75	48(.2)	19(.1)	113(.7)	19(.1)	4(T)	1(T)	2(T)	206(1.1)
4-75	23(.1)	11(T)	58(.2)	4(.3)	0	0	0	96(.6)
4-75	14(T)	23(.5)	65(.8)	1(T)	0	0	0	103(1.3)
7-75	1	10	26	3	0	2	0	42
7-75	0	7	59	5	0	1	0	72
7-75	2	4	41	1	0	1	0	49
11-75	117	27	138	6	0	78	2	368
11-75	77	40	91	1	0	0	26	235
11-75	70	27	83	3	0	26	0	209
2-76	228(1.4)	25(.2)	147(1.6)	6(T)	0	5(T)	3(T)	414(3.2)
2-76	231	20	102	5	0	1	3	362
2-76	90(.6)	24(T)	45(.3)	3(T)	0	0	0	162(.9)
5-76	23	22	51	12	0	6	0	114
5-76	11	24	86	20	0	3	0	144
5-76	9	14	38	9	2	0	1*	73
	West Fork Stillwater River - Station 007							
8-70	18	15	224	8	4	3	0	272
4-71	69(.1)	14(.1)	228(1.2)	5(T)	8(T)	0	23(T)	347(1.4)
10-71	90(.2)	13(T)	64(.1)	3(.3)	36(T)	99(T)	0	305(.6)
10-71	71(.4)	25(.1)	138(.3)	18(.3)	11(T)	3(T)	0	226(1.1)
10-71	103(.2)	20(.4)	70(.3)	2(.4)	1(T)	27(T)	0	223(1.3)
2-72	186(.2)	22(.2)	89(.5)	13(.3)	0	17(T)	7(T)	334(1.2)
2-72	170(.4)	37(.2)	115(.6)	64(2.5)	0	36(T)	4(T)	426(3.7)
2-72	230(.5)	25(.2)	196(1.1)	59(2.5)	2(T)	13(T)	3(T)	528(4.3)
5-72	48(.1)	6(.1)	366(.9)	10(T)	0	31(T)	0	461(1.1)
5-72	54(.1)	9(T)	260(.6)	104(.2)	3(T)	19(T)	1(T)	450(.9)
5-72	61(.1)	31(.2)	283(1.1)	24(.2)	6(T)	38(T)	1(T)	444(1.6)
8-72	76(.2)	6(T)	97(.3)	59(.1)	1(T)	62(T)	1(T)	302(.6)
8-72	6(T)	3(T)	29(.1)	2(T)	1(T)	2(T)	0	43(.1)
8-72	25(.1)	1(T)	39(.2)	11(.7)	1(T)	0	2(T)	79(1.0)
2-73	277(.4)	46(.4)	265(1.3)	26(.3)	3(T)	195(T)	10(T)	822(2.4)
2-73	71(.2)	55(.4)	251(1.5)	20(.1)	4(T)	108(T)	14(T)	523(2.2)
2-73	100(.6)	73(.5)	214(1.4)	41(.7)	15(T)	333(.1)	28(T)	804(3.3)
5-73	61(.2)	24(.1)	123(.5)	86(.5)	34(.1)	12(T)	27(.1)	367(1.5)
5-73	21(.3)	15(.1)	124(.8)	24(.1)	4(T)	254(.1)	5(T)	447(1.4)
5-73	56(.8)	48(.4)	208(.5)	38(.2)	12(T)	247(.1)	15(T)	624(2.0)
7-73	29(.5)	9(T)	169(.4)	36(T)	2(T)	186(.1)	3(T)	434(1.0)
7-73	13(T)	11(T)	54(.4)	11(T)	0	38(T)	3(T)	130(.4)
7-73	12(.1)	20(.2)	162(.2)	23(T)	1(T)	43(T)	1(T)	262(.5)
10-73	121(.2)	36(.1)	131(.3)	10(.4)	6(T)	39(T)	8(.1)	351(1.1)
10-73	250(.3)	32(.2)	170(.5)	12(.1)	9(T)	9(T)	20(.1)	502(1.2)
10-73	83(.3)	31(.1)	90(.2)	10(.3)	0	54(T)	7(T)	275(.9)
2-74	105(.2)	22(.1)	64(.2)	12(T)	0	11(T)	6(T)	220(.5)
2-74	27(.2)	31(.1)	88(.7)	5(T)	8(T)	0	3(T)	162(1.0)
2-74	17(T)	14(.1)	90(.3)	17(.1)	5(T)	17(T)	22(T)	182(.5)

Appendix S. Continued

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other[a]	Total
		West Fork Stillwater River - Station 007 - continued						
5-74	31(.1)	20(.1)	136(.6)	5(T)	0	8(T)	2(T)	202(.8)
5-74	47(.1)	10(.1)	107(.2)	7(.1)	1(T)	8(T)	4(T)	184(.5)
5-74	86(.1)	22(.2)	156(.9)	7(T)	1(T)	61(T)	13(T)	346(1.2)
7-74	4(T)	9(.2)	59(.7)	4(T)	2(T)	0	0	78(.9)
7-74	18(.1)	25(.1)	50(.4)	11(.1)	1(T)	27(T)	0	132(.7)
7-74	9(T)	22(T)	42(.1)	9(T)	0	0	1(T)	83(.1)
10-74	74(.2)	28(.1)	341(.5)	20(.5)	3(T)	282(.1)	4(T)	752(1.4)
10-74	25(.1)	44(T)	176(.3)	18(T)	4(T)	4(T)	1(T)	272(.4)
10-74	46(.1)	17(.1)	169(.3)	16(T)	6(T)	50(T)	6(T)	310(.5)
		West Fork Stillwater River - Station 076						
7-75	7	2	38	4	0	2	0	53
7-75	9	5	51	5	1	2	1	74
7-75	11	4	38	4	0	2	1	60
11-75	17	12	86	305	0	4	1	425
11-75	75	46	118	112	5	15	3	374
11-75	18	55	92	257	0	19	1	442
2-76	111	38	141	558	0	4	2	854
2-76	62(.5)	25(.7)	104(1.4)	388(.6)	0	0	4	583
2-76	60	25	43	420	0	4	2	554
4-76	13	45	66	292	0	5	4	425
4-76	12	7	39	271	0	8	11	348
4-76	21	19	63	192	0	5	2	302
		West Fork Stillwater River - Station 036						
8-70	26	27	207	16	3	18	1	298
10-71	85(.4)	17(.3)	182(1.1)	80(.2)	8(T)	0	34(T)	406(2.0)
10-71	26(.1)	58(.5)	93(.6)	13(T)	9(T)	0	24(T)	223(1.2)
10-71	40(.3)	26(.4)	136(1.1)	82(.3)	5(T)	0	8(T)	297(2.1)
2-72	153(.5)	23(.1)	348(1.6)	180(.3)	8(T)	242(.1)	1(T)	955(2.6)
2-72	161(.7)	38(.6)	441(2.4)	80(.6)	13(T)	187(.1)	3(T)	925(4.4)
2-72	83(.2)	39(.3)	136(.6)	31(.1)	9(.1)	52(T)	1(T)	351(1.3)
5-72	17(.5)	0	88(.4)	11(T)	3(T)	10(T)	2(T)	131(.9)
5-72	22(.1)	2(T)	68(.5)	37(.1)	1(T)	7(T)	0	137(.7)
5-72	12(.5)	3(.1)	28(.7)	0	0	0	0	43(1.3)
8-72	27(T)	7(.1)	79(.3)	32(T)	4(T)	109(T)	8(T)	266(.4)
8-72	29(.1)	5(.3)	124(.1)	25(.2)	6(T)	11(T)	1(T)	201(.7)
8-72	58(.3)	29(.5)	151(.4)	29(T)	4(T)	66(T)	2(T)	339(1.2)
2-73	227(1.6)	47(.6)	419(2.1)	134(.3)	5(T)	142(T)	1(T)	975(4.6)
2-73	89(.5)	27(.2)	324(2.5)	56(1.3)	9(T)	190(.1)	3(T)	698(4.6)
2-73	36(.1)	33(.1)	121(.8)	32(.3)	2(T)	63(T)	5(T)	292(1.3)
5-73	40(.1)	88(.5)	221(.9)	66(.3)	7(.1)	57(T)	3(T)	482(1.9)
5-73	39(.1)	20(.1)	185(.8)	48(.1)	10(T)	68(T)	4(T)	374(1.1)
5-73	39(.5)	71(.1)	426(1.5)	91(.5)	8(T)	187(T)	1(T)	823(2.6)
7-73	29(.1)	27(.3)	182(.5)	37(.4)	8(T)	47(T)	6(T)	336(1.3)
7-73	86(.6)	49(.3)	561(2.6)	151(.2)	8(T)	134(.1)	6(T)	995(3.8)
7-73	28(.1)	24(.4)	213(1.8)	119(.3)	5(T)	22(T)	10(T)	421(2.6)
10-73	111(.2)	65(.1)	378(.5)	13(.7)	9(T)	81(.1)	3(T)	660(1.6)
10-73	67(.1)	52(.1)	218(.3)	11(.1)	15(T)	31(T)	7(T)	401(.6)
10-73	100(.3)	60(.2)	228(.3)	16(.6)	10(T)	49(T)	1(T)	464(1.4)
2-74	239(2.2)	67(.4)	317(1.5)	114(1.2)	9(T)	308(.2)	5(T)	1059(5.5)
2-74	37(.2)	15(.1)	141(.8)	47(.3)	4(T)	113(.1)	1(T)	358(1.5)

Appendix S. Continued

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other[a]	Total
West Fork Stillwater River - Station 036 - continued								
2-74	62(.2)	66(.2)	286(1.1)	26(.4)	5(T)	129(.1)	9(T)	583(2.0)
5-74	19(.1)	28(.2)	234(.7)	39(.1)	1(T)	15(T)	1(T)	337(1.1)
5-74	30(.3)	49(.1)	238(.4)	114(.4)	9(T)	42(T)	9(T)	491(1.2)
5-74	49(.2)	72(.2)	190(.8)	39(T)	1(T)	17(T)	4(T)	372(1.2)
7-74	29(T)	17(.3)	111(.2)	33(.1)	2(T)	19(T)	2(T)	213(.6)
7-74	33(1.9)	50(.3)	174(.4)	77(.3)	8(T)	84(T)	5(T)	431(2.9)
7-74	28(.1)	20(.1)	71(.3)	26(.1)	8(T)	12(T)	2(T)	167(.6)
10-74	50(.1)	89(.2)	146(.3)	8(.2)	9(T)	80(T)	2(T)	384(.8)
10-74	71(.2)	23(.1)	189(.8)	32(.3)	7(T)	23(T)	1(T)	346(1.4)
10-74	34(.1)	14(.1)	140(.3)	13(T)	7(T)	60(T)	1(T)	266(.5)
Cathedral Creek - Station 018								
8-72	23(.1)	5(T)	14(.1)	102(.1)	0	1(T)	1(T)	146(.3)
8-72	21(T)	18(.1)	33(.1)	18(T)	0	0	0	90(.2)
8-72	9(T)	7(.2)	15(.2)	37(.1)	0	0	0	68(.5)
7-73	10(T)	4(.1)	3(T)	22(T)	0	11(T)	1(T)	51(.1)
7-73	22(.1)	8(.2)	7(.1)	28(T)	0	9(T)	0	74(.4)
7-73	48(.1)	6(.1)	8(T)	99(T)	0	65(.1)	2(T)	228(.3)
7-74	26(.1)	13(T)	17(.1)	55(T)	0	7(T)	5(T)	123(.2)
7-74	9(T)	11(.1)	12(.1)	4(T)	0	18(T)	0	54(.2)
7-74	40(.1)	17(.1)	24(.2)	169(.1)	0	31(T)	15(.1)	296(.6)
Initial Creek - Station 017								
8-72	5(T)	1(T)	6(T)	7(T)	0	10(T)	0	29(T)
8-72	5(T)	0	6(T)	24(T)	0	6(T)	0	41(T)
8-72	6(T)	3(.1)	8(.1)	223(.2)	1(T)	17(T)	0	258(.4)
7-73	3(.1)	3(.1)	25(.1)	26(T)	1(T)	1(T)	0	59(.3)
7-73	5(T)	5(.1)	25(.1)	4(T)	0	0	2(.1)	41(:3)
7-73	63(.1)	2(.1)	38(.1)	42(T)	0	0	0	145(.3)
7-74	1(T)	0	11(T)	10(T)	0	0	0	22(T)
7-74	4(T)	0	13(T)	0	0	0	0	17(T)
7-74	2(T)	0	4(.1)	3(T)	0	0	1(T)	10(.1)
Iron Creek - Station 019								
8-72	5(T)	0	16(T)	0	0	58(T)	1(T)	80(T)
8-72	9(T)	0	30(T)	3(T)	0	1(T)	0	43(T)
8-72	4(.1)	3(.1)	31(T)	12(T)	0	112(T)	1(T)	163(.2)
7-73	32(T)	7(.1)	58(.1)	14(T)	0	1(T)	2(T)	114(.2)
7-73	6(.1)	1(T)	14(T)	10(T)	0	1(T)	2(T)	34(.1)
7-73	34(.2)	10(.2)	58(.1)	18(T)	0	0	6(T)	126(.5)
7-74	19(T)	3(T)	69(.1)	64(.1)	0	0	4(T)	159(.2)
7-74	11(T)	5(.3)	25(.1)	10(T)	0	2(T)	1(T)	54(.4)
7-74	30(.8)	5(T)	53(.2)	4(.1)	0	0	4(T)	96(1.1)
Castle Creek - Station 077								
7-75	2	2	9	4	1	0	3	21
7-75	1	1	12	1	0	2	1	18
7-75	2	1	9	3	2	0	2	19
11-75	26	43	37	16	10	2	8	142
11-75	4	17	13	8	3	5	2	52
11-75	5	10	31	11	2	0	2	61
2-76	18	15	24	77	0	1	0	135
2-76	46	19	58	92	0	0	3	218

Appendix S. Continued

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other[a]	Total
4-76	11	26	82	11	0	1	6	137
4-76	2	9	41	12	0	1	3	68
4-76	1	4	6	2	0	0	0	13
			Castle Creek - Station 079					
7-75	3	10	32	1	0	6	3	55
7-75	9	22	54	2	0	4	7	98
7-75	12	9	24	0	1	4	6	56
11-75	23	39	41	60	2	36	9	210
11-75	36	97	38	93	0	25	0	289
11-75	63	159	105	140	3	66	3	539
2-76	10	34	49	123	0	34	5	255
2-76	1	32	21	56	2	23	8	143
2-76	3	29	29	89	0	34	3	187
4-76	15	61	124	120	1	44	11	376
4-76	3	40	130	42	0	10	7	232
4-76	13	20	187	68	0	2	21	311
			Castle Creek - Station 080					
7-75	2	15	106	57	1	3	5	189
7-75	6	5	21	11	0	0	3	46
7-75	2	22	66	22	2	2	4	120
11-75	34	64	131	41	0	16	0	286
11-75	10	62	89	28	2	1	1	193
11-75	18	151	105	25	0	26	2	327
2-76	14	66	89	777	0	3	4	953
2-76	4	42	69	502	0	0	8	625
2-76	27	83	68	576	0	16	9	779
4-76	14	136	285	67	3	8	7	520
4-76	4	18	122	67	0	5	4	220
4-76	9	81	369	71	0	1	12	543
			Picket Pin Creek - Station 020					
8-72	38(T)	4(.1)	127(.3)	88(T)	2(T)	8(T)	58(.1)	325(.5)
8-72	32(.1)	6(T)	295(.7)	118(.1)	8(T)	33(T)	102(.2)	594(1.1)
8-72	58(.1)	6(T)	303(.7)	87(.1)	10(T)	35(T)	90(.1)	589(1.0)
7-73	31(T)	6(.1)	68(.2)	26(.1)	3(T)	110(T)	22(.1)	266(.5)
7-73	20(.1)	5(.1)	169(.5)	12(T)	0	46(T)	38(.1)	290(.8)
7-73	107(.3)	4(.1)	122(.3)	66(T)	2(T)	333(.1)	86(.3)	720(1.1)
7-74	10(T)	1(T)	43(.2)	8(T)	0	5(T)	14(.1)	81(.3)
7-74	8(T)	5(.1)	41(.1)	2(T)	0	1(T)	2(T)	59(.2)
7-74	38(.2)	7(.1)	38(.1)	10(T)	1(T)	6(T)	27(.1)	127(.5)
			Picket Pin Creek - Station 078					
7-75	5	35	24	3	0	4	2	73
7-75	3	40	16	0	0	2	1	62
7-75	3	15	12	2	1	2	2	37
11-75	54	21	84	93	6	19	5	282
11-75	38	7	49	30	2	1	2	129
11-75	34	14	76	116	4	18	3	265
2-76	64	18	115	53	0	3	3	256
2-76	60	37	134	71	0	20	8	330
2-76	59	28	111	56	0	15	1	270
4-76	32	40	76	39	0	4	4	195
4-76	14	18	94	23	2	8	4	163
4-76	5	24	75	11	1	5	5	126

Appendix T. Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stationson the Deer creeks.

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other[a]	Total
			Lower Deer Creek - Station 021					
8-72	4(T)[b]	14(T)	50(.1)	5(T)	5(T)	5(T)	5(T)	88(.1)
8-72	13(T)	11(T)	57(.1)	1(T)	3(T)	2(T)	4(T)	91(.1)
8-72	33(T)	8(.1)	80(.1)	7(.2)	18(T)	10(T)	10(T)	166(.5)
			Upper Deer Creek - Station 022					
8-72	42(.2)	62(.3)	97(.3)	71(.2)	37(T)	57(T)	3(T)	369(1.0)
8-72	23(.1)	128(.4)	175(.4)	73(.8)	39(T)	47(T)	5(T)	490(1.7)
8-72	26(.1)	130(.2)	131(.4)	53(.3)	43(.1)	23(T)	6(T)	412(1.1)

a). Mostly made up of Turbellaria, Nemotoda, and Hydracarina
b). Trace

Appendix U. Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the East Boulder River drainage.

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Others[a]	Total
			East Boulder River - Station 038					
8-72	15(.1)	14(T)	12(T)	15(.5)	15(T)	1(T)	2(T)	74(.6)
8-72	40(.1)	6(T)	53(.2)	12(T)	10(T)	3(T)	1(T)	125(.3)
8-72	38(.1)	20(.1)	28(.2)	9(.2)	19(T)	0	3(T)	117(.6)
7-73	23(.1)	4(.1)	65(.2)	43(.1)	10(T)	0	2(T)	147(.5)
7-73	25(.1)	2(T)	88(.3)	18(T)	28(.1)	0	3(T)	164(.5)
7-73	30(.1)	5(T)	44(.2)	56(T)	26(.1)	0	2(T)	163(.4)
9-73	18(.1)	9(.1)	62(.2)	14(.3)	31(T)	15(T)	4(T)	153(.7)
9-73	28(.2)	4(T)	72(.1)	26(T)	21(T)	21(T)	0	172(.3)
9-73	39(.3)	8(.1)	74(.1)	16(.1)	44(.1)	1(T)	4(.1)	186(.8)
10-73	14(.1)	7(.1)	25(.1)	6(T)	10(T)	4(T)	3(T)	69(.3)
10-73	36(.2)	7(T)	49(.1)	22(T)	16(T)	5(T)	7(T)	142(.3)
10-73	22(.1)	2(T)	44(.1)	11(T)	21(T)	2(T)	6(T)	108(.2)
7-74	13(.1)	1(T)	20(.1)	10(T)	8(T)	3(T)	0	55(.2)
7-74	29(.1)	1(T)	32(.1)	27(T)	13(.1)	1(T)	2(.1)	105(.4)
7-74	23(.1)	3(T)	44(.1)	11(T)	17(T)	1(T)	0	99(.2)
			East Boulder River - Station 061					
7-74	8(T)	17(.1)	85(.2)	4(T)	1(T)	13(T)	1(T)	129(.3)
7-74	13(.1)	9(T)	89(.1)	2(T)	0	19(T)	2(T)	134(.2)
7-74	16(.2)	14(T)	92(.2)	5(T)	3(T)	5(T)	1(T)	136(.4)
9-74	14(T)	15(.2)	74(.2)	5(T)	1(T)	10(T)	1(T)	121(.4)
9-74	5(.1)	9(T)	40(.2)	0	0	13(T)	3(T)	70(.3)
9-74	22(.2)	29(.6)	79(.2)	1(T)	1(T)	2(T)	2(T)	136(1.0)
			East Boulder River - Station 008					
10-70	63	52	239	64	24	1	7	450
4-71	54(.1)	8(T)	120(.3)	1(T)	12(T)	0	22(T)	217(.4)
10-71	12(T)	8(.2)	55(.3)	0	5(T)	0	5(T)	85(.5)
10-71	83(.3)	43(.3)	135(.8)	13(T)	16(T)	1(T)	18(T)	309(1.4)
10-71	89(1.0)	33(1.2)	118(.6)	9(T)	7(T)	0	2(T)	258(1.8)
2-72	106(.5)	8(.1)	174(1.0)	10(.3)	6(T)	28(T)	7(T)	339(1.9)
2-72	103(.15)	12(.1)	171(.8)	13(.1)	2(T)	11(T)	5(T)	317(1.5)
2-72	107(.5)	11(T)	111(.5)	4(T)	5(T)	10(T)	1(T)	249(1.0)
5-72	27(.5)	12(.1)	137(.7)	4(T)	10(.1)	28(T)	1(T)	219(1.4)
5-72	53(.1)	12(T)	208(.7)	8(.4)	13(.1)	146(.1)	5(T)	445(1.4)
5-72	20(.1)	12(.1)	105(.3)	7(.3)	17(.1)	59(.1)	5(T)	225(1.0)
8-72	2(T)	16(.1)	28(.2)	4(T)	0	0	0	50(.3)
8-72	26(.1)	55(.2)	81(.3)	4(T)	1(T)	1(T)	9(.1)	177(.7)
8-72	36(.1)	24(T)	93(.3)	39(.1)	6(T)	31(T)	5(T)	234(.5)
2-73	43(.2)	26(.4)	166(1.0)	9(T)	25(T)	20(T)	4(T)	293(1.6)
2-73	37(.1)	9(.2)	130(.2)	3(T)	3(T)	7(T)	3(T)	192(.5)
2-73	68(.3)	10(.2)	243(1.8)	14(T)	14(T)	59(T)	7(T)	415(2.3)
5-73	43(.1)	13(.1)	80(.3)	8(T)	4(T)	3(T)	0	151(.5)
5-73	32(.2)	12(.1)	115(.8)	8(T)	11(T)	59(T)	7(T)	244(1.1)
5-73	30(.1)	56(.5)	292(2.0)	12(.1)	15(T)	25(T)	15(T)	445(2.7)
7-73	43(.2)	13(T)	134(.6)	11(T)	7(T)	42(T)	11(T)	261(.8)
7-73	9(T)	25(.3)	75(.8)	6(.1)	3(T)	0	3(T)	121(1.2)
7-73	34(.8)	33(.3)	169(.5)	28(.6)	15(T)	53(T)	8(T)	340(2.2)

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other[a]	Total
			East Boulder River - Station 008 (continued)					
10-73	207(.1)	64(.7)	245(.4)	10(T)	15(T)	67(T)	14(T)	622(1.2)
10-73	208(.2)	138(1.6)	220(.5)	40(.1)	13(T)	19(T)	15(.1)	653(2.5)
10-73	94(.2)	45(.4)	206(.2)	24(.1)	11(T)	36(T)	6(T)	422(.9)
2-74	42(1.7)	20(.2)	121(.6)	10(T)	12(T)	23(T)	3(T)	231(2.5)
2-74	131(.2)	36(.2)	225(1.0)	16(.2)	21(T)	83(T)	2(T)	514(1.6)
2-74	42(.2)	20(.2)	107(.7)	20(T)	12(T)	15(T)	2(T)	218(1.1)
5-74	49(.1)	24(.2)	79(.8)	2(T)	0	8(T)	2(T)	164(1.1)
5-74	43(.3)	46(.3)	109(1.2)	8(T)	11(T)	49(T)	25(T)	291(1.8)
5-74	60(.1)	55(.4)	157(.9)	12(.1)	9(T)	216(.1)	15(T)	524(1.6)
7-74	14(.1)	17(.1)	135(.2)	8(.1)	9(T)	27(T)	9(T)	219(.5)
7-74	41(.1)	19(.1)	195(.3)	68(.1)	7(T)	25(T)	2(T)	357(.6)
7-74	30(.3)	3(T)	90(.1)	18(T)	19(T)	2(T)	3(T)	165(.4)
10-74	111(.3)	20(.1)	288(.4)	65(T)	18(T)	50(T)	5(T)	557(.8)
10-74	113(.2)	20(.5)	246(.4)	17(.4)	5(T)	40(T)	10(T)	451(1.5)
10-74	272(.3)	75(.6)	227(.3)	14(T)	8(T)	24(T)	3(T)	628(1.2)
			East Boulder River - Station 009					
10-70	98	162	152	261	4	0	0	677
04-71	82(.1)	217(2.0)	585(1.0)	790(.9)	10(T)	0	10(T)	1694(4.9)
10-71	44(1.1)	279(3.2)	142(1.8)	124(1.7)	4(T)	0	51(T)	644(7.8)
10-71	64(.7)	307(4.1)	146(1.4)	138(.5)	4(T)	0	23(T)	682(6.7)
10-71	76(1.3)	385(5.4)	142(1.0)	236(1.5)	2(T)	0	49(T)	890(9.2)
02-72	226(.6)	353(2.5)	599(.8)	1077(.8)	5(T)	166(T)	4(T)	2430(4.7)
02-72	207(2.5)	104(.4)	320(.4)	1176(.8)	10(T)	269(T)	3(T)	2089(4.1)
02-72	70(.2)	184(.9)	194(.2)	337(.5)	4(T)	102(T)	2(T)	893(1.7)
05-72	8(.2)	13(.1)	39(.2)	63(2.2)	1(T)	41(T)	6(T)	171(2.7)
05-72	10(.1)	54(.4)	200(.8)	193(1.8)	6(T)	74(T)	9(T)	546(3.1)
05-72	7(.1)	34(.1)	169(1.1)	260(2.1)	3(T)	8(T)	7(T)	488(3.4)
08-72	98(.3)	35(.4)	311(.6)	165(.2)	5(T)	17(T)	5(T)	636(1.5)
08-72	154(.5)	14(.1)	224(.6)	135(.7)	10(T)	8(T)	10(.1)	555(2.0)
08-72	34(.1)	41(.4)	84(.2)	122(.2)	2(T)	23(T)	1(T)	307(.9)
02-73	42(1.8)	508(1.8)	145(.3)	161(1.3)	39(T)	18(T)	4(T)	917(5.2)
02-73	268(2.3)	261(1.8)	104(.4)	762(2.4)	31(T)	0	2(T)	1428(6.9)
02-73	170(1.9)	266(1.1)	69(.2)	963(2.9)	47(.1)	0	2(T)	1517(6.2)
05-73	68(1.1)	160(1.6)	255(1.3)	579(.6)	1(T)	357(T)	9(T)	1429(4.6)
05-73	57(1.2)	375(2.1)	163(.4)	353(2.2)	34(T)	0	8(T)	990(5.9)
05-73	38(.2)	555(2.9)	251(1.3)	290(1.7)	44(.1)	268(.1)	23(T)	1469(6.3)
07-73	46(.1)	14(.1)	342(.7)	180(.4)	7(T)	18(T)	4(T)	611(1.3)
07-73	72(.3)	55(.2)	308(1.0)	70(.7)	9(T)	18(.1)	3(T)	535(2.3)
07-73	27(T)	25(.2)	225(.5)	66(.4)	6(T)	38(T)	14(T)	401(1.1)
10-73	173(.6)	211(.4)	216(.7)	1701(3.2)	10(T)	107(.1)	24(T)	2442(5.0)
10-73	100(.4)	753(3.5)	66(.2)	128(.9)	21(T)	0	8(T)	1076(5.0)
10-73	168(.7)	496(2.1)	121(.3)	858(1.8)	3(T)	22(T)	5(T)	1673(4.9)
02-74	33(.8)	403(1.4)	108(.1)	266(1.1)	25(T)	17(T)	2(T)	854(3.4)
02-74	117(2.4)	773(4.3)	197(.4)	551(1.6)	23(T)	34(T)	4(T)	1699(8.7)
02-74	324(1.3)	2025(9.3)	621(.8)	1585(3.5)	195(.1)	156(.1)	64(T)	4970(15.1)
05-74	23(.2)	586(1.9)	448(1.1)	323(1.2)	21(T)	96(T)	35(.1)	1532(4.5)
05-74	28(.3)	1137(3.7)	752(1.1)	506(2.2)	31(T)	88(T)	29(.1)	2571(7.4)
05-74	33(.6)	873(5.5)	607(1.6)	363(3.2)	24(T)	23(T)	11(.1)	1934(11.0)

Appendix U. Continued

Date	Plecop-tera	Trichop-tera	Ephemer-optera	Dip-tera	Coleop-tera	Anne-lida	Other[a]	Total
			East Boulder River - Station 009 (continued)					
7-74	8(T)	2(T)	28(.1)	23(.1)	1(T)	2(T)	0	64(.2)
7-74	8(.1)	4(T)	24(T)	18(.2)	1(T)	23(T)	3(T)	81(.3)
7-74	17(.1)	13(.3)	41(.3)	33(.1)	4(T)	10(T)	0	118(.8)
10-74	35(.6)	49(.1)	60(.2)	45(.5)	6(T)	0	0	195(1.4)
10-74	85(1.3)	220(.9)	110(.2)	112(.4)	17(T)	16(T)	4(T)	564(2.8)
10-74	54(.1)	298(1.7)	80(.2)	39(.1)	7(T)	14(T)	3(T)	495(2.1)
			Forge Creek - Station 051					
7-73	13(.1)	1(T)	55(.1)	9(T)	1(T)	0	0	79(.2)
7-73	17(T)	4(T)	78(.2)	26(T)	5(T)	0	2(T)	132(.2)
7-73	15(T)	4(T)	45(.1)	10(T)	1(T)	12(T)	1(T)	88(.1)
9-73	27(.1)	13(.1)	14(.1)	0	8(T)	0	5(T)	67(.3)
9-73	38(.1)	6(T)	17(.1)	6(T)	2(T)	2(T)	0	71(.2)
9-73	10(T)	2(T)	6(T)	1(T)	3(T)	0	0	22(T)
7-74	20(.1)	1(T)	27(.1)	9(T)	2(T)	0	2(T)	61(.2)
7-74	37(.1)	3(T)	16(.1)	13(T)	1(T)	3(T)	1(T)	74(.2)
7-74	10(T)	0	15(T)	1(T)	1(T)	0	2(T)	29(T)
			Brownlee Creek - Station 060					
7-74	11(.1)	4(.1)	31(.1)	8(T)	0	2(T)	3(T)	59(.3)
7-74	19(.1)	4(T)	36(.2)	11(T)	0	6(T)	1(T)	77(.3)
7-74	26(.1)	12(.2)	63(.2)	12(.1)	1(T)	5(T)	2(T)	121(.6)
9-74	36(.2)	4(T)	45(.2)	7(T)	0	1(T)	3(T)	96(.4)
9-74	67(.4)	5(T)	18(T)	24(.1)	1(T)	15(T)	4(T)	134(.5)
9-74	38(.1)	8(.2)	3(T)	7(.3)	0	6(T)	0	62(.6)
			Brownlee Creek - Station 053					
8/6/74	29(.1)	13(.1)	31(.1)	2(T)	0	4(T)	5(T)	84(.3)
8/6/74	57(.1)	19(.3)	82(.2)	15(.1)	0	14(T)	5(T)	192(.7)
8/6/74	50(.1)	25(.1)	76(.2)	8(T)	0	13(T)	6(T)	178(.4)
10/3/74	28(.1)	13(.1)	129(.1)	18(T)	0	5(T)	9(.1)	202(.4)
10/3/74	16(.1)	23(T)	25(.2)	0	0	0	5(T)	69(.3)
10/3/74	28(.1)	35(.4)	73(.3)	6(T)	0	16(.1)	17(.2)	175(1.1)

Appendix V. Number and volume (in parentheses) of macroinvertebrates collected in one square foot stream bottom samples for stations in the Boulder River drainage.

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other[a]	Total
			Boulder River - Station 011					
10-70	31	67	103	16	0	33	0	250
04-71	127(1.2)	29(.4)	131(1.4)	34(T)[b]	0	0	37(T)	358(3.0)
10-71	51(.1)	18(.2)	39(.1)	6(T)	0	0	6(T)	120(.4)
10-71	75(.2)	33(.7)	292(.9)	2(.4)	0	0	34(T)	436(2.2)
10-71	19(.1)	18(.7)	101(.4)	0	0	0	8(T)	146(1.2)
05-72	22(.5)	4(.1)	29(.1)	66(.4)	0	1(T)	2(T)	124(1.1)
05-72	16(.7)	0	11(T)	61(T)	0	0	0	88(.7)
05-72	20(.1)	1(T)	12(.1)	2(T)	0	0	0	35(.2)
08-72	28(.8)	12(T)	113(.3)	6(T)	0	3(T)	4(T)	166(1.1)
08-72	15(T)	48(.2)	126(.6)	12(.5)	0	0	1(T)	202(1.3)
08-72	30(1.0)	78(.4)	190(.5)	13(T)	2(T)	6(T)	5(T)	324(1.9)
02-73	11(.2)	47(.5)	230(.8)	2(T)	0	4(T)	1(T)	295(1.5)
02-73	10(.1)	43(.4)	310(1.5)	3(T)	0	15(T)	2(T)	383(2.0)
02-73	56(.2)	93(.3)	237(1.0)	10(T)	1(T)	5(T)	3(T)	406(1.5)
05-73	33(.1)	42(.4)	72(1.1)	13(.2)	0	10(T)	0	174(1.8)
05-73	17(T)	29(.2)	68(.9)	12(.1)	0	50(T)	3(T)	179(1.2)
05-73	39(.5)	33(.6)	89(1.3)	11(T)	0	12(T)	3(T)	187(2.4)
07-73	50(.1)	12(T)	364(1.2)	41(.1)	0	18(T)	8(.1)	493(1.5)
07-73	4(T)	5(T)	98(.3)	15(.2)	0	59(T)	0	181(.5)
07-73	29(T)	37(.3)	126(1.1)	5(.1)	0	42(T)	6(T)	245(1.5)
10-73	17(.4)	52(.1)	136(.3)	3(T)	0	12(T)	0	220(.8)
10-73	98(.1)	129(.7)	273(.4)	7(.1)	2(T)	107(T)	11(T)	627(1.3)
10-73	43(.1)	23(.1)	245(.6)	10(.1)	1(T)	24(T)	8(T)	354(.9)
05-74	21(.2)	13(.2)	84(.8)	12(.7)	0	1(T)	20(.1)	151(2.0)
05-74	51(.3)	2(T)	122(.7)	6(.1)	0	0	33(.1)	214(1.2)
05-74	25(.2)	0	70(.9)	2(T)	0	0	5(T)	102(1.1)
7-74	10(T)	7(T)	81(.3)	3(.1)	0	4(T)	3(T)	108(.4)
7-74	18(T)	16(.2)	59(.3)	3(T)	0	0	2(T)	98(.5)
7-74	11(T)	14(.3)	37(.7)	2(T)	0	1(T)	5(T)	70(1.0)
10-74	20(.1)	62(.4)	107(.3)	9(T)	1(T)	6(T)	5(T)	210(.8)
10-74	15(T)	39(.1)	67(.2)	2(T)	1(T)	2(T)	0	126(.3)
10-74	11(.4)	59(.5)	105(.2)	0	0	1(T)	3(T)	179(1.1)
			Boulder River - Station 050					
10-70	35	28	138	5	3	13	0	222
04-71	48(.1)	76(1.0)	118(.3)	31(T)	0	0	0	273(1.4)
10-71	154(.2)	94(.4)	153(.6)	4(T)	2(T)	62(.1)	0	469(1.3)
10-71	77(.2)	66(.3)	130(.5)	4(.1)	1(T)	69(T)	0	347(1.1)
10-71	169(.2)	141(1.1)	255(1.0)	13(.1)	0	24(T)	0	602(2.4)

a). Mostly made up of Turbellaria, Nematoda, and Hydracarina
b). Trace

Appendix V. Continued

Date	Plecop-tera	Trichop-tera	Ephemer-optera	Dip-tera	Coleop-tera	Anne-lida	Other[a]	Total
			Boulder River - Station 010					
10-70	40	29	99	4	5	21	0	198
04-71	38(.2)	14(.1)	93(.8)	7(T)	0	0	74(T)	226(1.1)
10-71	116(.3)	62(.4)	172(.6)	9(.1)	0	3(T)	3(T)	365(1.4)
10-71	50(.1)	55(.3)	121(.4)	11(.2)	0	4(T)	0	241(1.0)
10-71	109(.3)	86(.5)	150(.4)	7(.2)	1(T)	37(T)	0	390(1.4)
02-72	70(.4)	25(.1)	117(.7)	13(T)	4(T)	69(.1)	1(T)	299(1.3)
02-72	73(.6)	12(.2)	136(.9)	9(.1)	2(T)	61(.1)	0	293(1.9)
02-72	17(.1)	2(T)	44(.4)	3(T)	2(T)	10(T)	0	78(.5)
05-72	8(.3)	1(T)	10(T)	3(T)	0	0	0	22(.3)
05-72	19(1.0)	5(T)	40(.2)	22(T)	0	0	0	86(1.2)
05-72	21(.3)	0	39(.2)	16(T)	0	0	0	76(.5)
08-72	12(T)	23(.2)	58(.2)	15(.1)	1(T)	1(T)	0	110(.5)
08-72	9(T)	40(.3)	118(.2)	11(T)	6(T)	2(T)	1(T)	187(.5)
08-72	30(.1)	74(.4)	137(.4)	19(.1)	2(T)	42(T)	1(T)	305(1.0)
02-73	38(1.0)	105(1.6)	257(1.6)	19(.3)	4(T)	23(T)	0	446(4.5)
02-73	13(.4)	123(.8)	211(2.0)	11(T)	1(T)	2(T)	0	361(3.2)
02-73	16(.2)	72(.6)	184(1.1)	12(T)	3(T)	69(T)	0	356(1.9)
05-73	47(.3)	5(T)	108(.7)	14(.1)	10(T)	24(T)	1(T)	209(1.1)
05-73	33(.3)	3(T)	119(.7)	8(T)	0	33(T)	0	196(1.0)
05-73	8(T)	9(.2)	95(.9)	0	1(T)	4(T)	1(T)	118(1.1)
07-73	64(.1)	13(T)	141(.8)	11(T)	0	55(T)	0	284(.9)
07-73	29(.1)	2(T)	98(.1)	12(.1)	0	20(T)	2(T)	163(.3)
07-73	31(.1)	1(T)	69(.3)	16(.2)	1(T)	3(T)	0	121(.6)
10-73	61(.3)	46(T)	243(.4)	6(T)	0	70(T)	0	426(.7)
10-73	42(.5)	72(.2)	201(.4)	9(.1)	0	22(T)	0	346(1.2)
10-73	63(.4)	159(1.0)	206(.3)	11(.3)	0	11(T)	2(T)	452(2.0)
02-74	28(.1)	55(.3)	132(.5)	11(.2)	1(T)	8(T)	2(T)	237(1.1)
02-74	70(.3)	44(.3)	130(.4)	2(T)	0	6(T)	1(T)	253(1.0)
02-74	77(.4)	35(.4)	266(1.4)	8(.2)	2(T)	18(T)	2(T)	408(2.4)
05-74	56(.5)	32(.5)	165(.7)	5(.3)	2(T)	6(T)	3(T)	269(2.0)
05-74	36(.5)	1(.2)	115(.4)	3(.3)	0	2(T)	2(T)	159(1.4)
05-74	29(2.1)	1(T)	141(.9)	6(T)	0	1(T)	0	178(3.0)
7-74	27(.4)	13(.2)	99(.2)	21(1.1)	0	4(T)	0	164(.9)
7-74	6(T)	1(T)	18(.1)	9(T)	0	1(T)	0	35(.1)
7-74	35(.1)	1(T)	64(.1)	16(T)	0	2(T)	0	118(.2)
10-74	68(.1)	45(.1)	331(.5)	11(.4)	3(T)	44(T)	1(T)	503(1.1)
10-74	56(.1)	11(T)	280(.5)	7(.1)	3(T)	82(T)	2(T)	441(.7)
10-74	47(.3)	20(.1)	213(.4)	10(.1)	1(T)	22(T)	0	313(.3)

Appendix V. Continued

Date	Plecop-tera	Trichop-tera	Ephemer-optera	Dip-tera	Coleop-tera	Anne-lida	Other[a]	Total
			Boulder River - Station 039					
10-70	8	84	49	33	1	0	2	177
04-71	48(.2)	288(.3)	337(1.2)	271(.2)	9(.1)	0	0	953(2.0)
10-71	10(T)	129(2.3)	79(.7)	11(.1)	2(T)	0	3(T)	234(3.1)
10-71	4(T)	90(.5)	37(.2)	30(.4)	4(T)	0	2(T)	167(1.1)
10-71	1(T)	23(.1)	42(.3)	17(.2)	1(T)	0	0	84(.6)
02-72	55(.2)	34(.3)	180(.5)	969(.5)	3(T)	25(T)	4(T)	1270(1.5)
02-72	41(.1)	126(.8)	157(.7)	53(3.5)	0	57(T)	9(T)	443(5.1)
02-72	18(.1)	31(.1)	65(.3)	3(T)	0	17(T)	1(T)	135(.5)
05-72	8(.2)	5(T)	53(.2)	29(.7)	1(T)	18(T)	0	114(1.1)
05-72	14(.2)	15(T)	12(.1)	11(.2)	0	3(T)	0	55(.5)
05-72	21(.2)	22(.1)	72(.4)	11(T)	0	15(T)	0	141(.7)
08-72	20(.2)	20(.1)	143(.4)	107(.2)	10(T)	0	0	300(.9)
08-72	15(T)	8(T)	39(.1)	36(.1)	2(T)	2(T)	2(T)	104(.2)
08-72	15(.1)	30(.2)	172(.3)	35(.1)	4(T)	1(T)	2(T)	259(.7)
02-73	3(T)	144(.2)	43(.1)	49(T)	1(T)	0	1(T)	241(.3)
02-73	73(.4)	118(.5)	171(.8)	255(1.1)	4(T)	47(T)	22(T)	690(2.8)
02-73	26(.9)	171(.5)	77(.3)	62(.3)	4(T)	19(T)	13(T)	372(2.0)
05-73	7(T)	247(.4)	212(.3)	53(.2)	5(T)	25(T)	6(T)	555(.9)
05-73	21(.1)	361(1.9)	310(.5)	66(.3)	3(T)	34(T)	9(T)	804(2.8)
05-73	16(T)	206(.8)	215(1.1)	122(.2)	4(T)	26(T)	7(T)	596(2.1)
07-73	7(.1)	30(.2)	122(.1)	26(.1)	3(T)	0	0	188(.5)
07-73	3(T)	13(T)	195(.2)	59(.1)	7(T)	11(T)	4(T)	292(.3)
07-73	7(.2)	13(T)	144(.2)	59(.1)	7(T)	7(T)	1(T)	238(.5)
10-73	42(T)	403(.9)	139(.3)	120(.7)	15(T)	41(T)	8(T)	768(1.9)
10-73	25(.1)	166(1.1)	148(.4)	60(.9)	3(T)	19(T)	5(T)	426(2.5)
10-73	2(T)	231(.5)	33(.1)	16(.1)	2(T)	5(T)	3(T)	292(.7)
02-74	8(T)	122(.2)	39(.2)	36(.2)	1(T)	6(T)	4(T)	216(.6)
02-74	3(T)	84(.1)	36(.1)	34(.1)	4(T)	0	2(T)	163(.3)
02-74	4(T)	63(.1)	38(.2)	54(.2)	2(T)	1(T)	1(T)	163(.5)
05-74	19(1.1)	203(.8)	141(.2)	66(1.7)	9(T)	2(T)	0	440(3.8)
05-74	7(.3)	17(.8)	73(.2)	28(.1)	2(T)	3(T)	1(T)	131(1.4)
05-74	22(.2)	9(T)	86(.3)	33(T)	3(T)	0	4(T)	157(.5)
7-74	14(T)	11(T)	121(.3)	7(T)	2(T)	0	1(T)	155(.3)
7-74	21(T)	2(T)	68(.1)	5(T)	1(T)	0	0	98(.1)
7-74	21(T)	0	66(.1)	1(T)	0	0	12(T)	88(.1)
10-74	78(.2)	252(1.2)	187(.2)	110(.4)	11(T)	0	2(T)	650(2.0)
10-74	15(T)	37(.3)	46(.2)	75(.5)	10(T)	0	3(T)	185(1.0)
10-74	10(.1)	17(T)	17(.1)	48(.1)	2(T)	3(T)	0	80(.3)

Boulder River - Station 040

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other	Total
10-71	17(1.2)	102(.3)	91(.2)	20(T)	4(T)	0	0	234(1.7)
10-71	5(T)	44(.1)	30(.1)	3(.1)	2(T)	13(T)	0	97(.3)
10-71	28(.2)	210(1.1)	101(.3)	7(T)	1(T)	19(T)	0	366(1.6)
02-72	84(.4)	282(.9)	461(1.1)	96(2.1)	6(T)	425(.1)	0	1354(4.6)
02-72	74(.6)	375(1.0)	651(1.7)	34(.6)	4(T)	736(.2)	1(T)	1875(4.1)
02-72	158(.3)	290(1.0)	648(2.4)	29(.5)	4(T)	855(.3)	0	1984(4.5)
05-72	20(.7)	55(.1)	146(.4)	11(T)	1(T)	4(.2)	1(T)	238(1.4)
05-72	51(.3)	210(.4)	147(.5)	126(.1)	15(T)	89(T)	0	638(1.3)
05-72	55(1.5)	342(.5)	208(.5)	42(T)	3(T)	18(T)	1(T)	669(2.5)
08-72	13(.3)	38(.2)	152(.3)	68(.6)	6(T)	14(T)	0	291(1.4)
08-72	24(1.0)	37(.2)	164(.2)	140(.3)	8(T)	8(T)	3(T)	384(1.7)
08-72	37(1.1)	54(.4)	153(.3)	144(.5)	13(T)	25(T)	4(T)	430(2.4)
02-73	9(.1)	306(.6)	228(.7)	244(.9)	24(T)	158(T)	0	969(2.3)
02-73	37(2.1)	120(.3)	89(.2)	109(.5)	4(T)	50(T)	0	410(3.1)
02-73	36(1.5)	641(2.5)	365(1.7)	222(1.4)	14(T)	176(.1)	18(T)	1472(7.2)
05-73	15(T)	159(.4)	187(.6)	53(.5)	6(T)	86(T)	5(T)	511(1.5)
05-73	7(.1)	418(1.2)	1343(1.9)	332(.9)	14(T)	81(T)	2(T)	2197(4.1)
05-73	62(.1)	207(.5)	675(1.1)	304(.7)	14(T)	112(T)	4(T)	1378(2.4)
07-73	46(.1)	37(.1)	460(.6)	193(.2)	15(T)	65(T)	4(T)	820(1.0)
07-73	8(.3)	22(.3)	146(.5)	371(.6)	6(T)	9(T)	1(T)	563(1.7)
07-73	28(.1)	21(.1)	203(.5)	402(.9)	13(T)	61(T)	8(T)	736(1.6)
10-73	9(T)	66(T)	6(T)	10(.1)	6(T)	14(T)	2(T)	113(.1)
10-73	17(.1)	349(2.4)	70(.2)	60(.4)	5(T)	42(T)	7(T)	550(3.1)
10-73	22(T)	180(.6)	62(.1)	40(.1)	12(T)	78(.1)	9(T)	403(.9)
02-74	7(T)	160(.8)	34(.2)	40(.4)	6(T)	2(T)	0	249(1.4)
02-74	49(1.8)	360(1.2)	231(.2)	173(.4)	18(T)	29(T)	0	860(3.6)
02-74	18(T)	558(2.7)	165(.4)	120(1.2)	14(T)	101(T)	3(T)	979(4.3)
05-74	7(.1)	225(.3)	479(.9)	83(.6)	32(.1)	11(T)	2(T)	839(2.0)
05-74	83(.3)	140(.5)	371(.9)	33(.1)	0	60(T)	0	687(1.8)
05-74	28(.7)	538(2.0)	818(2.0)	104(.4)	14(T)	94(T)	2(T)	1598(5.1)
7-74	3(T)	6(T)	28(.3)	14(.1)	1(T)	0	0	52(.4)
7-74	13(.1)	11(.1)	85(.2)	19(T)	3(T)	1(T)	0	132(.4)
7-74	18(.3)	9(.1)	123(.3)	118(.2)	5(T)	10(T)	1(T)	284(.9)

Bobcat (East Chippy) Creek-Station 023

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other	Total
8-72	20(T)	5(T)	75(.1)	4(T)	0	27(T)	0	131(.1)
8-72	22(T)	5(.1)	160(.1)	6(T)	0	1(T)	2(T)	196(.2)
8-72	45(T)	8(.1)	168(.1)	10(T)	0	89(T)	2(T)	322(.2)
8-73	163(.1)	8(.2)	94(.3)	13(T)	0	140(T)	6(T)	424(.6)
8-73	27(T)	7(.1)	48(.2)	4(T)	0	23(T)	2(T)	111(.3)
8-73	12(T)	3(T)	69(.2)	3(T)	0	27(T)	0	114(.2)
7-74	10(T)	5(.1)	26(.1)	0	0	0	0	41(.2)
7-74	0	1(T)	9(T)	2(T)	0	0	0	12(T)
7-74	6(T)	1(T)	25(.1)	2(T)	0	0	0	34(.1)

Appendix V. Continued

Date	Plecoptera	Trichoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Other[a]	Total
				Blakely Creek-Station 024				
8-72	2(T)	1(T)	10(.1)	1(T)	0	0	7(.1)	21(.2)
8-72	0	0	36(.1)	5(T)	0	0	3(T)	44(.1)
8-72	24(.1)	5(.1)	26(.1)	18(T)	0	0	42(.4)	115(.7)
8-73	119(.2)	13(.1)	156(.5)	47(.2)	0	23(T)	36(.2)	394(1.2)
8-73	125(.2)	15(.2)	181(.6)	15(T)	0	7(T)	51(.3)	394(1.3)
8-73	148(.1)	12(.1)	113(.5)	30(T)	0	3(T)	26(.1)	332(.8)
7-74	9(T)	2(.1)	66(.2)	13(T)	1(T)	2(T)	1(T)	94(.3)
7-74	5(T)	1(T)	34(.8)	1(T)	0	0	0	41(.8)
7-74	5(T)	3(T)	37(.3)	13(T)	0	0	0	58(.3)
				Graham Creek - Station 025				
7-74	3(.1)	8(.2)	14(.1)	24(T)	0	0	0	49(.4)
7-74	0	0	16(T)	18(.1)	2(T)	0	0	36(.1)
7-74	7(T)	0	29(.2)	15(.1)	0	0	0	51(.3)
				Great Falls Creek-Station 026				
8-72	6(T)	4(.4)	91(.2)	1(T)	0	0	0	102(.6)
8-72	8(.1)	5(.3)	67(.3)	3(T)	0	0	1(T)	84(.7)
8-72	18(.1)	2(.1)	119(.7)	4(T)	0	1(T)	1(T)	145(.9)
8-73	12(T)	2(T)	121(.2)	2(T)	0	14(T)	0	151(.2)
8-73	5(T)	1(T)	73(.1)	7(T)	0	0	5(T)	91(.1)
8-73	10(T)	6(.1)	57(.2)	8(.1)	0	5(T)	5(T)	91(.4)
				Falls Creek-Station 027				
8-72	6(T)	22(.1)	97(.8)	9(.1)	0	8(T)	0	142(1.0)
8-72	13(T)	16(T)	52(.3)	7(T)	0	1(T)	0	89(.3)
8-72	31(.1)	15(.2)	118(1.0)	20(T)	5(T)	6(T)	0	195(1.4)
8-73	23(.1)	2(T)	62(.1)	27(.1)	0	25(T)	0	139(.3)
8-73	18(.1)	2(.1)	45(.1)	3(T)	0	3(T)	1(T)	72(.3)
8-73	11(T)	3(.1)	40(.2)	8(T)	0	2(T)	0	64(.3)

Appendix V. Continued

Date	Plecop-tera	Trichop-tera	Ephemer-optera	Dip-tera	Coleop-tera	Anne-lida	Other[a]	Total
				West Boulder River - Station 041				
10-70	18	10	139	6	5	56	2	236
04-71	7(.1)	5(.1)	55(.2)	21(T)	1(T)	0	1(T)	90(.4)
10-71	29(.2)	21(.4)	178(.6)	10(T)	4(T)	0	18(T)	260(1.2)
10-71	25(.7)	34(.7)	126(.4)	3(T)	2(T)	125(T)	0	315(1.8)
10-71	33(.1)	6(T)	96(.4)	7(T)	1(T)	28(T)	0	171(.5)
02-72	54(.2)	10(T)	91(.2)	4(T)	2(T)	52(T)	2(T)	215(.4)
02-72	75(.2)	10(T)	123(.2)	9(T)	3(T)	0	3(T)	223(.4)
02-72	62(.1)	12(.1)	113(.2)	10(T)	1(T)	30(T)	3(T)	231(.4)
05-72	24(.9)	8(.3)	92(.6)	17(.1)	1(T)	7(.6)	0	149(2.5)
05-72	96(2.1)	12(.1)	389(1.0)	47(.1)	3(T)	1(T)	0	548(3.3)
05-72	13(.1)	0	63(.3)	5(T)	0	0	0	81(.4)
08-72	28(.3)	27(.3)	344(.3)	60(.1)	2(T)	65(T)	3(T)	529(1.0)
08-72	43(.1)	28(.7)	406(.6)	124(.1)	2(T)	18(T)	4(T)	625(1.5)
08-72	19(.1)	19(.1)	521(.8)	157(.1)	2(T)	20(T)	4(T)	742(1.1)
02-73	37(.2)	39(.2)	266(1.1)	20(.1)	1(T)	137(T)	1(T)	501(1.6)
02-73	71(1.1)	61(.2)	338(1.2)	86(1.1)	5(T)	200(T)	4(T)	765(3.6)
02-73	16(.1)	64(.5)	227(1.0)	21(.2)	3(T)	84(T)	0	415(1.8)
05-73	33(.1)	52(.3)	273(1.5)	89(.3)	4(T)	80(T)	0	531(2.2)
05-73	27(.1)	76(.3)	422(.9)	238(.3)	5(T)	295(.1)	0	1063(1.7)
05-73	18(.1)	19(.1)	203(.8)	97(.1)	2(T)	90(T)	1(T)	430(1.1)
07-73	33(.2)	12(.2)	214(.6)	63(.1)	5(T)	69(.1)	5(T)	401(1.2)
07-73	32(.2)	18(.3)	188(1.1)	49(.1)	2(T)	158(.3)	0	447(2.0)
07-73	48(.4)	7(.1)	323(1.3)	86(.1)	2(T)	114(.1)	0	580(2.0)
10-73	59(.2)	41(T)	126(.2)	12(.1)	1(T)	11(T)	0	250(.5)
10-73	77(.2)	31(T)	221(.2)	10(.1)	3(T)	60(T)	1(T)	403(.5)
10-73	82(.3)	40(.1)	224(.3)	11(.1)	1(T)	5(T)	0	363(.8)

Appendix W. Number of insects in one square foot stream bottom samples, identified to lowest taxa possible.

West Fork Stillwater River

Station 054-7/24/73

PLECOPTERA	
Nemoura sp	8
Alloperla sp	25
Total	33[a]

TRICHOPTERA	
Rhyacophila sp	17
Glossosoma sp	29
Total	46

EPHEMEROPTERA	
Baetis spp	26
Rhithrogena sp	87
Epeorus sp	5
Cinygmula sp	43
Ephemerella doddsi	1
Total	162

DIPTERA	
Chironomidae	4
Tipulidae (2 genera)	2
Total	6

COLEOPTERA	
Elmidae	2
Total	2

Station 037-5/30/73 #1

PLECOPTERA	
Nemoura spp	6
Alloperla sp	3
Acroneuria sp	1
Total	10

TRICHOPTERA	
Rhyacophila spp[b]	13
Glossosoma sp	4
Psychomyia sp	3
Micrasema sp	2
Dolophilodes aequalis	1
Total	23

EPHEMEROPTERA	
Baetis sp	46
Rhithrogena sp	16
Epeorus sp	6
Cinygmula sp	11
Ephemerella inermis	10
Ephemerella doddsi	6
Ephemerella grandis	1
Total	96

DIPTERA	
Diamesa sp	2
Dicranota sp	2
Total	4

Station 037-5/30/#2

PLECOPTERA	
Acroneuria sp	1
Alloperla sp	6
Nemoura sp	15
Capnia sp	1
Total	23

TRICHOPTERA	
Parapsyche sp	3
Rhyacophila sp	29
Glossosoma sp	1
Oligophlebodes sp	2
Total	35

EPHEMEROPTERA	
Epeorus grandis	32
Epeorus longimanus	6
Rithrogena robusta	20
Baetis spp	104
Cinygmula sp	19
Ephemerella doddsi	16
Ephemerella grandis	8
Ephemerella sp	5
Total	210

DIPTERA	
Diamesa sp	11
Rheotanytarsus sp	2
Dicranota sp	2
Total	15

a) Order totals may not agree exactly with numbers in Appendices S and U. This is probably due to minor counting inaccuracies at the Helena laboratory, by the identifier, or by both.

b) Three species.

Appendix W. Continued

West Fork Stillwater River

Station 007/5-3-73

PLECOPTERA	
Capnia sp	7
Nemoura sp	14
Alloperla sp	7
Acroneuria sp	4
Isogenus sp	11
unknown	11
Total	54
TRICHOPTEREA	
Rhyacophila sp	35
Glossosoma verdona	10
Brachycentrus sp	1
Ecclisomyia sp	1
Total	47
EPHEMEROPTERA	
Rhithrogena sp	14
Epeorus longimanus	69
Ephemerella inermis	51
Ephemerella doddsi	16
Ephemerella grandis	1
Baetis sp	6
Paraleptophlebia sp	2
Cinygmula sp	30
Ameletus sp	19
Total	208
DIPTERA	
Chironomidae	6
Pericoma sp	7
Holorusia sp	1
2 unknown genera	22
Total	36
COLEOPTERA	
Heterlimnius sp	12

Station 036/2-8-72

PLECOPTERA	
Nemoura spp	29
Acroneuria sp	6
Capnia sp	6
Alloperla sp	48
Total	89
TRICHOPTERA	
Rhyacophila spp	12
Hydropsyche sp	2
Arctopsyche sp	2
Glossosoma sp	19
unknown Limnephilidae	3
Total	38
EPHEMEROPTERA	
Ameletus sp	3
Baetis sp	44
Ephemerella doddsi	6
Ephemerella inermis	10
Ephemerella grandis	1
Ephemerella spinifera	2
Epeorus sp	7
Paraleptophlebia sp	1
Rithrogena sp	20
Cinygmula sp	54
Total	148
DIPTERA	
Pericoma sp	14
Hexatoma sp	2
Diamesa sp	3
Micropsectra sp	3
Orthocladius sp(probably)	2
Ablabesmyia sp	1
unknown	4
Total	29
COLEOPTERA	
Heterlimnius sp	6

Appendix W. Continued

East Boulder River - Station 009/5-2-73

Sample #1

PLECOPTERA

Acroneuria pacifica	4
Capnia sp	3
Alloperla sp	15
Nemoura sp	3
Isoperla fulva	36
Unknown *Isoperla* sp	1
Total	62

TRICHOPTERA

Arctopsyche grandis	11
Hydropsyche sp	95
Brachycentrus sp	24
Lepidostoma sp	18
Glossosoma sp	8
Rhyacophila acropedes	2
Rhyacophila bifila	3
Total	161

EPHEMEROPTERA

Baetis bicaudatus	1
Baetis tricaudatus	39
Baetis sp	2
Epeorus longimanus	20
Ephemerella doddsi	21
Ephemerella grandis grandis	2
Ephemerella coloradensis	55
Ephemerella inermis	88[c]
Cinygmula sp	15
Rithrogena hageni	6
Rithrogena robusta	2
	251

COLEOPTERA

Optioservus sp	1

DIPTERA[d]

Wiedemannia sp	24
Chelifera sp	32
unknown Empididae	17
Hexatoma sp	44
Limonia sp	107
unknown Tipulidae	1
Bibiocephala sp	1
unknown psychodidae	164
Atherix sp	44
unknown Chironomidae	400+
Total	834+

Sample #2

PLECOPTERA

Acroneuria pacifica	36
Isoperla fulva	9
Isoperla (prob. *fulva*)	2
Alloperla sp	10
Nemoura sp	1
Total	58

TRICHOPTERA

Arctopsyche grandis	6
Hydropsyche sp	269
Brachycentrus sp	9
Lepidostoma sp	5
Glossosoma sp	69
Rhyacophila acropedes	2
Rhyacophila bifila	13
Total	373

EPHEMEROPTERA

Baetis tricaudatus	21
Ephemerella spinifera	1
Ephemerella grandis grandis	1
Ephemerella coloradensis	5
Ephemerella inermis	123[c]
Heptagenia sp	1
Cinygmula sp	3
Rithrogena hageni	2
Epeorus longimonus	4
Total	161

COLEOPTERA

Optioservus sp	28
Narpus sp	3
Total	31

Sample #3

PLECOPTERA

Acroneuria pacifica	10
Capnia sp	6
Alloperla sp	10
Nemoura sp	2
Isoperla fulva	4
Total	32

TRICHOPTERA

Arctopsyche grandis	8
Hydropsyche sp	285
Brachycentrus sp	33
Lepidostoma sp	9
Glossosoma sp	212
Rhyacophila acropedes	3
Rhyacophila bifila	5
Micrasema sp	1
Total	556

EPHEMEROPTERA

Baetis tricaudatus	49
Ephemerella doddsi	15
Ephemerella grandis grandis	4
Ephemerella coloradensis	65
Ephemerella inermis	81[c]
Cinygmula sp	10
Epeorus longimonus	11
Total	235

COLEOPTERA

Optioservus sp	42
Narpus sp	4
Total	46

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d) Samples #1, #2, & #3 were grouped together.
c) May contain some *Ephemerella infrequens*.

Appendix X. Fish population estimates for the period 1971 - 1974.

Age class	Mean length (inches)			Mean weight (lbs.)			Estimated number			Estimated weight (lbs.)			Pounds per acre			Mortality rate (%)	
	1972	1973	1974	1972	1973	1974	1972	1973	1974	1972	1973	1974	1972	1973	1974	1972 -73	1973 -74
Stillwater River - Section F-2 - March, April																	
Brown Trout																	
0	---	3.5	3.6	---	0.01	0.01	---	1208	1012	---	16.8	14.1					
I	6.0	5.9	5.9	0.08	0.08	0.08	377	462	327	30.4	35.3	25.4					73
II	9.1	9.5	9.0	0.26	0.29	0.25	258	96	99	67.3	27.6	24.6				75	79
III	11.9	12.6	12.1	0.55	0.65	0.57	187	109	57	103.2	70.7	32.8				58	40
IVand older	15.0	15.3	15.2	1.14	1.18	1.10	79	50	23	90.1	59.4	25.8				81	85
						Totals	901 (±172)[a]	1927 (±597)	1518 (±278)	290 (±33)	209 (±23)	122 (±11)	20.6	15	8.7		
Brook Trout																	
0	4.2	4.0	3.9	0.02	0.02	0.02	134	1296	88	3.4	28.5	1.6					
I	6.8	6.6	6.6	0.11	0.10	0.10	128	81	69	14.0	8.1	6.8				40	95
II	9.5	9.0	8.5	0.28	0.23	0.20	53	9	12	14.7	2.1	2.5				93	85
						Totals	315 (±147)	1386 (±831)	169 (±45)	32.1 (±16)	38.7 (±19)	10.9 (±3)	2.3	2.7	0.9		
Silver Creek - Section F-7 - Brown Trout - June																	
0	2.6	2.4	2.5	0.01	0.01	0.01	192	1036	697	2.0	10.4	7.0					
I	5.0	5.0	4.7	0.05	0.05	0.04	106	258	254	5.0	12.7	10.2					75
II[b]	7.1	7.0	7.4	0.14	0.13	0.15	78	57	70	10.6	7.4	10.6				46	79
III	9.2	8.9	---	0.27	0.24	----	24	19	---	6.5	4.7	----				75	
						Totals	400 (±140)	1370 (±262)	1020 (±128)	24.1 (±5)	35.2 (±3)	27.8 (±3)	127	185	148.		

a-95% confidence interval in parentheses   b-Age group II and older in 1974

Appendix X. Continued

Age class	Mean length (inches) 1972	1973	1974	Mean weight (lbs.) 1972	1973	1974	Estimated number 1972	1973	1974	Estimated weight (lbs.) 1972	1973	1974	Pounds per acre 1972	1973	1974	Mortality rate (%) 1972-73	1973-74
Little Rocky Creek - Section F-8 - Brown Trout - June, July																	
I	----	3.8	4.5	----	0.01	0.03	----	70	411	----	1.0	13.8					
II	6.7	7.1	7.8	0.13	0.14	0.20	76	30	26	9.8	4.4	5.4					62
III and older	11.2	10.7	11.2	0.62	0.53	0.63	65	73	40	39.8	38.3	24.8				48	62
						Totals	141 (±17)	173 (±33)	477 (±151)	49.6 (±6)	43.7 (±12)	44.0 (±14)	59.3	53	52		
Boulder River - Section F-4 - March, April																	
Rainbow Trout																	
0	----	2.5	2.7	----	0.01	0.01	----	957	2306		9.5	23.1					
I	5.5	5.0	5.4	0.07	0.05	0.06	98	139	142	6.5	7.0	8.0					85
II	9.0	8.8	9.4	0.26	0.23	0.29	91	88	52	23.8	20.6	15.0				11	63
III	12.9	12.0	11.9	0.79	0.63	0.58	68	242	49	53.7	151.1	28.1					45
IV	16.8	16.1	15.7	1.67	1.50	1.35	249	250	299	415.3	374.3	404.1				21	39
						Totals	506 (±192)	1676 (±465)	2848 (±663)	499.3 (±253)	562.5 (±173)	478.3 (±131)	51.0	58.0	49.0		
Brook Trout																	
0	3.5	3.2	3.5	0.01	0.01	0.01	1787	6927	2023	22.6	74.3	25.3					
I	6.0	5.6	5.6	0.08	0.06	0.06	955	1361	737	73.8	86.0	44.1				24	89
II[b]	8.6	9.1	9.4	0.20	0.25	0.31	124	511	49	25.0	126.9	15.0				47	97
III	12.7	12.3	----	0.66	0.62	----	12	43	---	8.2	26.5	---				66	
						Totals	2878 (±937)	8842 (±2221)	2809 (±563)	129.6 (±25)	313.7 (±90)	84.4 (±14)	13.3	32.0	8.6		

Appendix X. Continued

Age class	Mean length (inches) 1st year	Mean length (inches) 2nd year	Mean weight (lbs.) 1st year	Mean weight (lbs.) 2nd year	Estimated number 1st year	Estimated number 2nd year	Estimated weight (lbs.) 1st year	Estimated weight (lbs.) 2nd year	Pounds per acre 1st year	Pounds per acre 2nd year	Mortality rate (%) 1972 to 1973 or 1973 to 1974
East Rosebud River - Section F-14 - Brown Trout - November - 1971											
I	5.8		0.06		135		8.7				
II	9.1		0.25		159		39.7				
III	12.1		0.57		113		65.1				
IV	16.6		1.49		53		79.3				
Totals					460 (±105)a		192.8 (±55)		17.2		
Morris Creek - Section F-12 - Brook Trout - June 1972, June 1973											
I	5.0	4.4	0.05	0.03	465	758	23.4	20.8			
II	7.6	6.9	0.17	0.12	105	142	18.3	16.9			69
III	9.0	9.2	0.28	0.27	78	25	22.0	6.8			76
Totals					648 (±87)	925 (±189)	63.7 (±6)	44.5 (±6)	242	173	
West Fishtail Creek - Section F-10 - Brook Trout - July 1972, July 1973											
I	4.6	4.6	0.04	0.04	118	93	4.4	3.6			
II and older	7.7	7.2	0.19	0.16	28	57	5.5	9.1			61
Totals					146 (±70)	150 (±42)	9.9 (±5)	12.7 (±5)	9.4	12.0	

Appendix X. Continued

Age class	Mean length (inches) 1st year	Mean length (inches) 2nd year	Mean weight (lbs.) 1st year	Mean weight (lbs.) 2nd year		Estimated number 1st year	Estimated number 2nd year	Estimated weight (lbs) 1st year	Estimated weight (lbs) 2nd year	Pounds per acre 1st year	Pounds per acre 2nd year	Mortality rate (%) 1972 to 1973 or 1973 to 1974
East Fishtail Creek - Section F-9 - Rainbow Trout - July 1972, July 1973												
I	---	2.8	---	0.01		---	113	---	1.2			
II	4.9	4.7	0.05	0.04		16	69	0.7	2.9			
IIIand older	8.3	7.8	0.28	0.22		10	24	2.7	5.2			9
					Totals	26	206	3.4	9.3	4.3	13	
						(±11)	(±84)	(±2)	(±3)			
Fishtail Creek - Section F-11 - July, 1972, August, 1973												
Rainbow Trout												
I	---	3.7	---	0.01		---	1002	---	14.4			
II	5.5	6.0	0.08	0.09		174	158	13.3	14.7			
III	8.0	8.0	0.22	0.21		41	86	9.0	18.1			51
IVand older	10.8	10.8	0.52	0.50		29	34	14.9	17.0			51
					Totals	244	1280	37.2	64.2	15.7	27.0	
						(±101)	(±270)	(±12)	(±8)			
Brown Trout												
I	---	4.8	---	0.04		---	330	---	14.3			
II	6.9	7.3	0.14	0.17		94	84	13.1	13.9			
III	9.8	10.4	0.39	0.46		56	90	21.5	41.7			4
IVand older	12.7	13.5	0.83	0.96		49	67	41.1	63.8			37
					Totals	199	571	75.7	133.7	30.5	53.0	
						(±46)	(±84)	(±18)	(±19)			

Appendix X. Continued

Age class	Mean length (inches) 1st year	Mean length (inches) 2nd year	Mean weight (lbs.) 1st year	Mean weight (lbs.) 2nd year	Estimated number 1st year	Estimated number 2nd year	Estimated weight (lbs.) 1st year	Estimated weight (lbs.) 2nd year	Pounds per acre 1st year	Pounds per acre 2nd year	Mortality rate (%) 1972 to 1973 or 1973 to 1974
Stillwater River - Section F-1 - May 1972; April, May 1973											
Brook Trout											
0	3.9	3.6	0.02	0.01	233	494	4.0	6.6			
I	5.6	6.0	0.06	0.08	151	296	9.5	22.4			
II	8.2	9.6	0.19	0.28	38	10	7.0	2.9			93
Totals					422 (±190)	800 (±203)	20.5 (±8)	31.9 (±8)	2.7	4.1	
Rainbow Trout											
0	---	2.4	---	0.01	---	481	---	4.8			
I	---	4.2	---	0.03	---	357	---	9.6			
II	---	6.9	---	0.12	---	54	---	6.3			
IIIand older	---	11.7	---	0.62	---	43	---	26.9		6.3	
Totals						935 (±346)		47.6 (±19)			
Stillwater River - Section F-3 - Brown Trout - November 1971											
I	6.0	---	0.06	---	604	---	38.7				
II	8.9	---	0.25	---	544	---	135.2				
III	12.3	---	0.65	---	224	---	145.2				
IVand older	15.3	---	1.24	---	149	---	186.1				
Totals					1521 (±460)		505.2 (±101)		47.8		

Appendix X. Continued

Age class	Mean length (inches) 1st year	Mean length (inches) 2nd year	Mean weight (lbs.) 1st year	Mean weight (lbs.) 2nd year		Estimated number 1st year	Estimated number 2nd year	Estimated weight (lbs.) 1st year	Estimated weight (lbs.) 2nd year	Pounds per acre 1st year	Pounds per acre 2nd year	Mortality rate (%) 1972 to 1973 or 1973 to 1974
Stillwater River - Section F-19 - Brown Trout - March, April - 1974												
0	3.9	---	0.02	---		1031	---	18.9	---			
I	6.9	---	0.12	---		590	---	68.7	---			
II	9.8	---	0.35	---		233	---	80.5	---			
IIIand older	13.0	---	0.74	---		134	---	99.2	---	47.5		
					Totals	1988 (±334)		267.3 (±30)				
Nye Creek - Section F-6 - Brook Trout - June 1973												
I	4.1	---	0.02	---		3	---	0.06	---			
IIand older	6.3	---	0.10	---		10	---	0.99	---			
					Totals	13 (±5)		1.05 (± 1)		6.0		
Mountain View Creek - Section F-5 - Brook Trout - June 1972, 1973												
I	4.5	4.6	0.04	0.04		100	84	4.1	3.1			
II	8.7	6.7	0.26	0.12		11	15	2.9	1.9			
					Totals	111 (±64)	99 (±23)	7.0 (±5)	4.0 (±2)	24.6	14.0	85
Picket Pin Creek - Section F-16 - August, September, 1972; September, 1973												
Brook Trout												
I	5.3	5.4	0.06	0.06		49	241	3.0	14.1			
IIand older	8.8	8.1	0.30	0.24		47	38	14.0	9.3			60
					Totals	96 (±13)	279 (±34)	17.0 (±1)	23.4 (±3)	26.6	38.0	

Appendix X. Continued

Age class	Mean length (inches) 1st year	Mean length (inches) 2nd year	Mean weight (lbs.) 1st year	Mean weight (lbs.) 2nd year	Estimated number 1st year	Estimated number 2nd year	Estimated weight (lbs.) 1st year	Estimated weight (lbs.) 2nd year	Pounds per acre 1st year	Pounds per acre 2nd year	Mortality rate(%) 1972 to 1973 or 1973 to 1974
Picket Pin Creek - Section F-16 - Continued											
Brown Trout											
I	4.4	4.2	0.03	0.02	22	70	0.6	1.5			
II	6.4	6.3	0.09	0.09	42	14	3.9	1.2			37
III	9.4	8.3	0.35	0.23	33	12	11.6	2.9			70
IVand older	11.3	12.0	0.59	0.69	8	7	4.9	4.9			83
Totals					105 (±14)	103 (±27)	21.0 (±3)	10.5 (±2)	34.0	19.0	
Cutthroat Trout											
I	5.1	5.2	0.05	0.05	27	23	1.3	1.2			
II	7.3	7.6	0.16	0.16	13	10	2.1	1.7			61
IIIand older	9.5	9.4	0.34	0.33	8	14	2.8	4.5			37
Totals					48 (±12)	47 (±12)	6.2 (±2)	7.4 (±2)	9.4	11.0	
West Fork Stillwater River - Section F-17 - April, May 1973, 1974											
Rainbow Trout											
I	4.3	4.4	0.03	0.03	359	489	10.4	14.8			
II	6.3	6.5	0.09	0.10	93	194	8.4	19.8			46
III	---	8.4	---	0.23	---	73	---	16.7			21
III and older	8.4	---	0.23	---	177	---	40.5	---			
IV and older		10.0	---	0.39	---	59	---	23.1			67
Totals					629 (±108)	815 (±106)	59.3 (±9)	74.4 (±16)	27.7	35.1	

Appendix X. Continued

Age class	Mean length (inches) 1st year	Mean length (inches) 2nd year	Mean weight (lbs.) 1st year	Mean weight (lbs.) 2nd year	Estimated number 1st year	Estimated number 2nd year	Estimated weight (lbs.) 1st year	Estimated weight (lbs.) 2nd year	Pounds per acre 1st year	Pounds per acre 2nd year	Mortality rate(%) 1972 to 1973 or 1973 to 1974
West Fork Stillwater River - Section F-17 - Continued											
Brown Trout											
I	4.8	5.1	0.04	0.05	34	102	1.5	5.2			
II	7.3	7.2	0.16	0.15	20	25	3.2	3.6			27
IIIand older	10.5	11.0	0.48	0.56	27	15	13.0	8.2			69
Totals					81 (±30)	142 (±23)	17.7 (±6)	17.0 (±3)	8.3	7.8	
West Fork Stillwater River - Section F-22 - Rainbow Trout - October, 1974											
I	5.3	---	0.06	---	27	---	1.5	---			
II	6.6	---	0.13	---	22	---	2.8	---			
III	8.1	---	0.23	---	46	---	10.4	---			
IVand older	9.8	---	0.40	---	82	---	33.0	---			
Totals					177 (±56)		47.7 (±17)		16.2		
Lower Deer Creek - Section F-18 - Brown Trout - June, July 1973											
I	4.4	---	0.03	---	197	---	5.6	---			
II	7.5	---	0.17	---	44	---	7.4	---			
III	11.2	---	0.50	---	58	---	28.9	---			
IVand older	14.1	---	0.88	---	38	---	33.8	---	21.3		
Totals					337 (±76)		75.7 (±11)				

Appendix X. Continued

Age class	Mean length (inches) 1st year	Mean length (inches) 2nd year	Mean weight (lbs.) 1st year	Mean weight (lbs.) 2nd year	Estimated number 1st year	Estimated number 2nd year	Estimated weight (lbs.) 1st year	Estimated weight (lbs.) 2nd year	Pounds per acre 1st year	Pounds per acre 2nd year	Mortality rate(%) 1972 to 1973 or 1973 to 1974
Boulder River - Section F-21 - Rainbow Trout - September 1974											
0	3.3	---	0.01	---	34	---	0.3	---			
I	5.2	---	0.06	---	304	---	18.2	---			
II	8.0	---	0.22	---	170	---	37.0	---			
III	10.2	---	0.44	---	77	---	34.2	---			
IVand older	12.7	---	0.87	---	80	---	70.4	---			
Totals					665 (+178)		160.1 (+58)		35.6		
East Boulder River - Section F-13 - July, August 1972; August 1973											
Rainbow Trout											
I	4.0	3.9	0.02	0.02	37	116	0.9	2.4			
II	5.1	5.2	0.05	0.05	145	41	7.5	2.1			
III	6.2	6.3	0.09	0.10	252	63	22.5	6.4			56
IV	8.2	7.3	0.21	0.15	62	203	12.9	30.7			19
Vand older	10.3	8.9	0.35	0.27	6	43	2.0	11.4			36
Totals					502 (+80)	466 (+70)	45.8 (+6)	53.0 (+6)	28.8	35.0	
Brown Trout											
II	4.1	4.7	0.02	0.04	11	46	0.3	1.8			
III	6.2	6.1	0.09	0.09	49	30	4.3	2.6			
IV	7.5	7.7	0.16	0.18	15	33	2.5	5.9			32
Vand older	10.9	9.2	0.51	0.32	7	21	3.8	6.8	7.1	11.0	7
Totals					82 (+25)	130 (+26)	10.9 (+3)	17.1 (+5)			

Appendix X. Continued

Age class	Mean length (inches)		Mean weight (lbs.)		Estimated number		Estimated weight (lbs.)		Pounds per acre		Mortality rate(%)
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1972 to 1973 or 1973 to1974
East Boulder River - Section F-20 - September 1974											
Rainbow Trout											
I	3.5	---	0.01	---	297	---	3.6	---			
II	5.5	---	0.06	---	177	---	10.9	---			
III	7.4	---	0.16	---	160	---	25.0	---			
IVand older	9.5	---	0.35	---	86	---	30.0	---			
				Totals	720 (±120)		69.5 (±8)		28.7		
Brown Trout											
I	4.1	---	0.02	---	98	---	2.1	---			
II	6.2	---	0.09	---	70	---	6.0	---			
III	8.0	---	0.20	---	88	---	17.4	---			
IVand older	11.6	---	0.63	---	38	---	24.2	---	20.1		
				Totals	294 (±48)		49.7 (±6)				

Appendix Y. Fish population estimates for stream sections in the West Fork Stillwater River drainage, 1975 - 1976.

Age class	Mean length (inches)		Mean weight (pounds)			Estimated number		Estimated weight(pounds)		Pounds per acre	
						West Fork Stillwater River - Section F-28 - October 1975 - Rainbow trout					
II	5.6		0.07			161		10.6			
III	7.5		0.16			81		13.1			
IV and older	9.5		0.34			43		14.7			
					Totals	285 (±129)[a]		38.7 (±17)		17.5	
						West Fork Stillwater River - Section F-26 - May 1975; April 1976 - Rainbow trout					
	1975	1976	1975	1976		1975	1976	1975	1976	1975	1976
I	3.8	3.3	0.02	0.01		278	106	4.5	1.1		
II	6.5	5.6	0.10	0.07		84	142	8.2	9.5		
III	8.5	8.1	0.23	0.20		33	63	7.5	12.6		
IV and older	10.1	9.9	0.40	0.39		50	44	19.8	17.2		
					Totals	445 (±176)	355 (±81)	40.0 (±7.8)	40.4 (±10.9)	20.6	20.8
						West Fork Stillwater River - Section F-29 - November 1975 - Rainbow trout					
I	3.8		0.01			82		1.2			
II	5.7		0.07			111		7.7			
III	8.1		0.21			37		7.7			
IV and older	10.4		0.44			49		21.2			
					Totals	279 (±89)		37.8 (±12)		24.7	
						West Fork Stillwater River - Section F-24 - April 1975 - Brown Trout					
0	3.7		0.01			478		7.1			
I	7.1		0.13			251		33.0			
II	9.9		0.36			296		105.3			
III and older	12.6		0.70			53		36.9			
					Totals	1078 (±123)		182.3 (±22)		51.3	

Appendix Y. Continued

Age Class	Mean length (inches)		Mean weight (pounds)			Estimated number		Estimated weight (pounds)		Pounds per acre	
					Rainbow Trout						
I	5.3		0.05			154		8.2			
II and older	7.8		0.19			211		40.5			
					Totals	365 (±48)		48.7 (±6)		13.8	
			Castle Creek - Section F-25 - April 1975; October 1975								
					Brown Trout						
	Spring	Fall	Spring	Fall		Spring	Fall	Spring	Fall	Spring	Fall
0	2.8	--	0.01	--		89	--	0.9	--		
I	4.8	4.3	0.04	0.03		56	40	2.2	1.1		
II and older	8.2	7.6	0.20	0.20		7	43	1.4	8.5		
					Totals	152 (±55)	83 (±14)	4.5 (±0)	9.6 (±2)	25.4	50.8
					Brook Trout						
0	3.8	3.3	0.02	0.01		321	159	5.3	1.6		
I	6.2	5.8	0.08	0.08		24	130	2.0	10.0		
II	8.6	8.7	0.21	0.30		5	11	1.0	3.4		
					Totals	350 (±28)	300 (±42)	8.3 (±0)	15.0 (±2)	45.7	76.1

a) 95% confidence interval in parentheses

Appendix Y. Continued

Age Class	Mean length (inches)		Mean weight (pounds)			Estimated number		Estimated weight (pounds)		Pounds per acre	
Castle Creek - Section F-27 - September 1975 - Brown Trout											
I	4.9		0.04			528		22.8			
II	7.5		0.16			185		30.0			
III and older	10.5		0.49			167		82.1			
					Totals	880 (±97)		134.9 (±6.2)		116.9	
Castle Creek - Section F-23 - April 1975; October 1975 - Brown Trout											
	Spring	Fall	Spring	Fall		Spring	Fall	Spring	Fall	Spring	Fall
0	3.7	3.0	0.02	0.01		1388	820	24.2	8.4		
I	6.7	6.0	0.11	0.08		214	414	22.8	32.9		
II and older	9.7	10.0	0.31	0.39		590	507	180.1	199.6		
					Totals	2192 (±278)	1741 (±302)	227.1 (±9)	240.9 (±27)	239	256
Picket Pin Creek - Section F-16 - September 1975											
Brown Trout											
I	4.5		0.03			18		0.6			
II	6.4		0.10			35		3.4			
III and older	10.3		0.44			32		13.8			
					Totals	85 (±17)		17.8 (±3.1)		28.1	
Brook Trout											
0	2.6		0.01			24		0.2			
I	5.4		0.06			39		2.5			
II and older	8.3		0.25			53		13.0			
					Totals	116 (±25)		15.7 (±3)		25.0	
Cutthroat Trout											
0	2.9		0.01			16		0.2			
I	4.5		0.03			4		0.1			
II and older	8.1		0.23			21		4.9			
						41 (±16)		5.2 (±2)		7.8	

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
Little Rocky Creek - F-8	Brown trout	6-72	5.3-8.8	II,III	54	50	35	77
			8.9-14.9	III & older	50	47	37	63
	Brown trout	7-73	3.2-3.9	I	23	27	11	55
			4.0-5.5	I	6	17	7	15
			5.6-7.2	II	9	23	12	17
			7.3-10.9	II, III	29	59	29	59
			11.0-15.0	III and older	12	16	7	27
	Brown trout	7-74	3.5-4.9	I	73	94	18	369
			5.0-8.7	I,II	31	37	17	67
			8.8-14.5	II, III and older	15	20	7	41
Picket Pin Creek F-16	Brook trout	9-72	4.2-6.8	I	34	23	16	48
			6.9-11.9	II and older	43	31	29	46
	Brown trout	9-72	3.6-6.0	I, II	26	11	8	35
			6.1-7.9	II	24	12	10	29
			8.0-9.8	III	24	18	18	24
			9.9-14.1	III,IV	13	11	8	18
	Cutthroat trout	9-72	4.2-6.3	I	15	13	7	27
			6.4-10.9	II,III	20	13	12	22
Picket Pin Creek F-16	Brook trout	9-73	4.0-6.9	I, II	132	191	102	247
			7.0-12.4	II and older	19	46	27	33
	Brown trout	9-73	3.5-5.1	I	23	52	17	70
			5.2-7.9	II, III	13	18	13	18
			8.0-8.9	III	4	12	8	6
			9.0-14.6	III, IV and older	8	8	7	9
	Cutthroat trout	9-73	4.3 - 5.9	I	11	19	9	23
			6.0-11.6	II, III and older	14	24	14	24

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
Picket Pin Creek F-16	Brook trout	9-75	2.2-5.3	0, I	21	15	7	43
			5.4-6.7	I	11	17	9	21
			6.8-8.2	II and older	19	15	10	28
			8.3-11.3	II and older	16	20	13	25
	Brown trout	9-75	3.5-5.6	I, II	11	19	8	26
			5.7-9.9	II,III and older	29	27	19	41
			10.0-13.4	III and older	15	10	8	19
	Cutthroat trout	9-75	2.6-14.0	0, I, II and older	22	19	10	41
West Fork Stillwater River F-22	Rainbow trout	10-74	4.3-7.8	I, II, III	23	31	10	69
			7.9-12.9	III, IV and older	44	28	11	108
West Fork Stillwater River F-28	Rainbow trout	10-75	4.7-12.2	II, III, IV and older	67	58	13	286
West Fork Stillwater River F-26	Rainbow trout	5-75	2.9-4.9	I, II	40	54	7	281
			5.0-6.9	II	28	33	15	61
			7.0-8.9	II, III	25	28	16	43
			9.0-12.6	III, IV and older	39	29	19	59
	Rainbow trout	4-76	2.7-4.1	I, II	28	29	7	108
			4.2-5.3	II	25	21	9	56
			5.4-6.7	II	38	23	11	77
			6.8-8.2	II, III	22	32	16	44
			8.3-11.8	III, IV and older	32	23	10	71
West Fork Stillwater River F-29	Rainbow trout	11-75	2.8-5.9	I, II	33	57	11	163
			6.0-6.9	II, III	13	14	6	29
			7.0-13.1	II, III, IV and older	29	46	15	87

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
West Fork Stillwater River F-17	Brown trout	5-73	4.2-8.7	I, II	24	19	8	55
			8.8-17.6	III and older	13	15	7	27
	Rainbow trout	5-73	3.4-3.9	0, I	31	43	9	140
			4.0-4.9	I	55	93	31	164
			5.0-5.9	I, II	27	28	8	89
			6.0-6.9	I, II	32	45	26	55
			7.0-8.9	II, III	70	73	34	149
			9.0-11.9	III and older	24	32	18	42
West Fork Stillwater River F-17	Brown trout	5-74	3.9-6.0	I	66	45	29	102
			6.1-8.9	II, III	17	14	9	26
			9.0-19.2	III and older	12	9	8	13
	Rainbow trout	5-74	3.0-3.9	0, I	52	42	14	151
			4.0-4.9	I	118	96	44	256
			5.0-5.9	I, II	59	41	24	100
			6.0-6.9	I, II	71	57	26	154
			7.0-8.9	II, III, IV and older	59	42	25	98
			9.0-11.7	III, IV and older	23	25	8	68
West Fork Stillwater River F-24	Brown trout	4-75	2.7-3.9	0	121	111	40	332
			4.0-5.5	0	46	52	16	146
			5.6-7.3	I	70	63	27	161
			7.4-8.9	I, II	77	61	31	150
			9.0-9.9	II	62	42	26	99
			10.0-12.9	II, III and older	85	72	36	169
			13.0-16.3	III and older	18	13	12	19
	Rainbow trout	4-75	3.8-5.6	I	59	47	23	119
			5.7-6.9	I, II and older	59	77	41	110
			7.0-8.9	II & older	53	43	25	90
			9.0-13.8	II & older	30	29	19	46

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
Castle Creek F-25	Brook trout	4-75	2.8-3.9	0	139	129	90	199
			4.0-5.1	0	84	100	69	122
			5.2-6.9	I	17	20	17	20
			7.0-9.6	I, II	9	7	7	9
	Brown trout	4-75	2.0-3.8	0	19	35	7	89
			3.9-5.4	I	40	30	22	54
			5.5-10.6	I, II and older	9	7	7	9
	Brook trout	10-75	2.3-3.0	0	18	18	8	39
			3.1-3.9	0	58	46	22	120
			4.0-6.9	I	89	87	63	123
			7.0-10.0	I, II	18	16	15	19
	Brown trout	10-75	3.6-4.9	I	22	26	16	36
			5.0-7.9	I, II and older	28	25	18	39
			8.0-12.5	II and older	8	8	7	9
Castle Creek F-27	Brown trout	9-75	3.4-4.9	I	140	92	37	344
			5.0-6.9	I, II	126	93	51	229
			7.0-9.9	II, III and older	155	140	109	199
			10.0-10.9	III and older	41	44	36	50
			11.0-14.6	III and older	57	42	41	58
Castle Creek F-23	Brown trout	4-75	2.2-3.2	0	55	76	9	430
			3.3-3.9	0	149	190	60	469
			4.0-4.9	0	184	209	81	473
			5.0-5.9	0, I	28	31	15	57
			6.0-8.9	I, II and older	248	247	180	340
			9.0-12.9	II and older	323	338	268	407
			13.0-15.9	II and older	15	12	12	15

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
	Brown trout	10-75	2.0-3.0	0	83	58	10	450
			3.1-3.9	0	84	54	12	359
			4.0-6.9	0, I	165	154	64	395
			7.0-9.9	I, II and older	172	161	95	291
			10.0-11.9	II and older	104	107	57	195
			12.0-15.9	II and older	26	23	11	53
Lower Deer Creek F-18	Brown trout	7-73	3.4-4.3	I	31	23	7	95
			4.4-4.9	I	17	36	7	82
			5.0-7.9	I, II	25	31	14	54
			8.0-9.9	II, III	12	18	10	21
			10.0-13.5	III, IV and older	33	41	25	54
			13.6-16.5	IV and older	24	18	14	31
Boulder River F-4	Brook trout	4-72	2.2-4.6	0	185	124	12	1787
			4.7-7.9	I, II	285	159	45	994
			8.0-13.9	II, III	47	30	14	98
	Rainbow trout	4-72	4.1-11.6	I, II, III	55	42	11	200
			11.7-21.9	III, IV and older	58	51	9	306
	Brook trout	4-73	2.2-3.9	0	534	416	33	6561
			4.0-5.9	0, I	123	253	22	1368
			6.0-7.9	I, II	29	189	11	474
			8.0-14.1	II, III	19	219	9	439
	Rainbow trout	4-73	1.8-3.9	0, I	151	102	15	978
			4.0-8.6	I, II	34	40	8	158
			8.7-11.6	II, III	25	55	9	145

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
			11.7-13.0	III, IV and older	55	66	31	116
			13.1-14.9	III, IV and older	48	38	23	79
			15.0-21.1	III, IV and older	44	48	10	199
	Brook trout	4-74	2.4-3.9	0	305	204	35	1742
			4.0-4.9	0, I	123	76	25	366
			5.0-6.9	I	169	134	35	637
			7.0-13.4	I, II and older	29	23	10	64
	Rainbow trout	4-74	1.8-2.9	0	262	226	30	1925
			3.0-3.4	0	97	71	19	352
			3.5-8.9	0, I, II	53	28	7	195
			9.0-11.9	II, III, IV and older	28	18	7	68
			12.0-14.0	III, IV and older	38	26	15	65
			14.1-15.9	IV and older	30	28	10	81
			16.0-17.9	IV and older	30	45	9	142
			18.0-22.4	IV and older	12	14	8	21
Boulder River F-21	Rainbow trout	9-74	2.4-4.9	0, I	42	50	12	168
			5.0-7.9	I, II	53	58	11	265
			8.0-9.9	II, III, IV, and older	26	38	9	104
			10.0-15.6	II, III, IV and older	21	58	9	129

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
East Boulder River F-13	Brown trout	8-72	3.7-6.8	II, III	28	23	11	57
			6.9-12.9	III, IV, V and older	15	14	8	26
	Rainbow trout	8-72	3.7-4.9	I, II	31	34	9	111
			5.0-6.3	II, III	105	117	56	218
			6.4-7.1	III	37	45	18	91
			7.2-7.8	III, IV	17	20	11	31
			7.9-8.9	IV	16	27	11	39
			9.0-11.9	IV, V	8	8	6	11
	Brown trout	8-73	3.8-4.9	I, II	22	14	9	34
			5.0-7.1	II, III, IV	31	17	10	51
			7.2-12.9	IV, V and older	30	21	13	48
	Rainbow trout	8-73	2.3-4.0	0, I	36	31	9	117
			4.1-5.7	I, II	61	65	42	94
			5.8-6.9	III, IV	77	74	45	126
			7.0-8.0	IV	74	78	49	118
			8.1-10.7	IV, V and older	43	31	20	66
East Boulder River F-20	Brown trout	9-74	3.2-4.9	I	42	38	16	98
			5.0-5.9	II	14	13	10	18
			6.0-7.9	II, III	43	47	21	95
			8.0-9.9	III, IV and older	39	28	21	52
			10.0-10.9	IV and older	8	8	8	8
			11.0-15.3	IV and older	17	22	16	23
	Rainbow trout	9-74	2.5-3.9	0, I	65	75	17	278
			4.0-4.9	I, II	34	39	21	63
			5.0-5.8	II	69	61	38	110
			5.9-7.3	II, III	63	84	45	117
			7.4-8.9	III, IV and older	63	76	44	109
			9.0-13.1	IV and older	33	37	21	58

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
East Rosebud River F-14	Brown trout	11-71	4.4-7.1	I	43	36	11	135
			7.2-10.6	II, III	66	40	15	171
			10.7-13.7	III	37	26	10	92
			13.8-19.9	III, IV	23	20	7	62
Morris Creek F-12	Brook trout	6-72	3.5-5.9	I	169	200	74	455
			6.0-6.9	I, II	17	25	16	27
			7.0-7.9	II, III	33	36	18	65
			8.0-8.9	II, III	37	41	27	56
			9.0-11.9	II, III	33	27	19	47
	Brook trout	6-73	2.8-3.9	I	23	63	8	170
			4.0-4.9	I	80	236	36	518
			5.0-5.8	I	17	70	17	70
			5.9-6.9	II	35	70	27	90
			7.0-7.9	II	19	41	19	41
			8.0-8.9	II, III	11	20	10	22
			9.0-10.6	III and older	10	17	12	14
West Fishtail Creek F-10	Brook trout	7-72	3.7-9.3	I, II and older	35	48	11	146
		7-73	3.5-5.3	I	40	47	20	93
			5.4-10.3	II and older	17	28	8	57
East Fishtail Creek F-9	Rainbow trout	7-72	4.3-11.5	II, III and older	15	14	8	26
		7-73	2.3-4.6	I, II	37	33	8	143
			4.7-10.9	II, III and older	22	27	9	63
Fishtail Creek F-11	Brown trout	7-72	6.0-7.9	II	38	29	12	89
			8.0-10.5	II, III	19	29	11	49
			10.6-11.7	III, IV and older	15	11	7	23
			11.8-17.9	IV and older	20	14	7	38

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
	Rainbow trout	7-72	4.0-5.9	I, II	55	37	10	192
			6.0-8.0	II, III	19	22	7	57
			8.1-13.0	III, IV and older	23	15	7	47
Fishtail Creek F-11	Brown trout	8-73	4.0-4.9	I	82	84	28	242
			5.0-6.9	I, II	44	89	33	118
			7.0-8.0	II	22	22	13	37
			8.1-9.3	II, III	23	26	17	35
			9.4-11.7	III	32	45	25	57
			11.8-12.6	III, IV	24	21	12	41
			12.7-18.4	IV and older	24	30	18	40
	Rainbow trout	8-73	2.8-3.9	0, I	137	166	28	794
			4.0-4.9	I	71	146	51	203
			5.0-5.9	I, II	49	61	32	93
			6.0-6.9	II	48	66	41	77
			7.0-7.9	II, III	35	50	39	45
			8.0-8.8	III	17	27	13	35
			8.9-12.8	III, IV and older	26	29	18	42
Stillwater River F-1	Brook trout	5-72	2.7-5.9	0, I	33	109	10	339
			6.0-10.0	I, II	21	45	11	83
	Brook trout	5-73	2.2-3.6	0	43	61	8	302
			3.7-6.6	0, I	130	191	59	418
			6.7-10.9	I, II	30	20	7	80
	Rainbow trout	5-73	1.7-3.4	0, I	47	85	7	515
			3.5-4.0	I	29	31	7	119
			4.1-4.9	I	68	48	19	168
			5.0-15.3	I, II, III and older	42	27	8	133
Stillwater River F-2	Brook and Brown trout	4-72	3.0-11.7	0, I, II	78	51	12	315
		4-72	4.5-7.6	I, II	96	73	17	398
			7.7-10.2	II	98	75	33	220
			10.3-11.4	II, III	53	30	19	83

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
			11.5-12.9	III	67	32	23	93
			13.0-14.6	III, IV	50	27	19	70
			14.7-23.9	IV and older	25	20	13	38
	Brook trout	4-73	2.6-5.2	0	94	108	7	1293
			5.3-5.9	0, I	13	19	12	21
			6.0-10.4	I, II	29	43	17	72
	Brown trout	4-73	2.4-4.9	0, I	94	213	15	1270
			5.0-7.5	I	156	168	68	384
			7.6-8.3	I, II	19	12	10	23
			8.4-10.3	II	60	48	40	72
			10.4-11.3	II, III	26	25	21	31
			11.4-13.0	III	49	36	29	61
			13.1-14.7	III, IV and older	33	22	13	55
			14.8-20.6	IV and older	22	17	12	31
	Brook trout	4-74	2.5-4.9	0, I	34	32	12	88
			5.0-5.9	0, I	10	9	8	11
			6.0-7.1	I	16	18	7	39
			7.2-9.2	I, II	16	14	7	31
Stillwater River F-2	Brown trout	4-74	2.6-3.9	0	132	198	31	826
			4.0-4.9	0, I	62	65	20	197
			5.0-5.9	0, I	64	98	39	160
			6.0-8.2	I, II	115	108	72	172
			8.3-8.9	II	33	22	18	40
			9.0-10.9	II, III	29	19	11	49
			11.0-12.9	II, III	34	35	31	38
			13.0-17.9	III, IV and older	30	17	14	36
Stillwater River F-3	Brown trout	11-71	3.7-9.4	I, II	187	84	15	998
			9.5-12.1	II, III	76	43	11	281
			12.2-21.9	III, IV and older	114	71	33	243

Appendix Z. Length groups used and numbers of fish captured in making population estimates.

Stream and Section number	Species	Date	Length group (inches)	Age(s)	Number of fish marked	Number of fish in recapture sample	Number of marked fish in recapture sample	Number estimate
Stillwater River F-19	Brown trout	4-74	2.8-4.9	0	186	191	34	1025
			5.0-6.9	0, I	102	123	37	335
			7.0-9.0	I, II	123	114	43	323
			9.1-9.9	II	41	42	28	61
			10.0-10.9	II, III and older	36	31	13	84
			11.0-12.9	II, III and older	52	47	24	101
			13.0-17.8	III and older	37	45	28	59
Silver Creek	Brown trout	6-72	1.7-4.5	0, I	31	54	7	219
			4.6-5.9	I, II	31	43	16	82
			6.0-7.9	II	38	48	31	59
			8.0-10.7	II, III	27	24	16	40
	Brown trout	6-73	1.7-2.9	0	179	259	46	995
			3.0-4.9	0, I	85	104	58	152
			5.0-5.9	I	84	81	49	138
			6.0-7.9	I, II	52	47	41	60
			8.0-10.9	II, III	22	18	15	26
	Brown trout	6-74	1.7-2.8	0	157	294	75	612
			2.9-3.9	0, I	54	86	35	132
			4.0-4.9	I	74	58	47	91
			5.0-5.9	I	66	54	33	107
			6.0-6.9	I, II and older	30	25	20	37
			7.0-9.6	II and older	30	22	16	41
Nye Creek F-6	Brook trout	6-73	4.1-7.3	I, II and older	9	12	8	13
Mountain View Creek F-5	Brook trout	6-72	3.2-10.0	I, II	30	28	7	111
	Brook trout	6-73	2.9-3.9	I	16	9	8	18
			4.0-4.9	I	19	16	7	42
			5.0-7.6	I, II	26	29	19	40

Appendix AA. Results of survey electrofishing.

Stream and location description	T	R	S	Stream section length (feet)	Species	Number caught	Length range (inches)	Fish age(s)	Date
East Fishtail Creek									
West fork near mouth	5S	16E	26	1000	Eb[a]	9	3.7-7.8	1,2	7-09-74
West fork of West Fork					LL	1	3.4	1	
near mouth	5S	16E	35	500	Eb	1	3.8	-	7-10-74
0.5 miles above mouth	5S	16E	34	500	-	0	-	-	7-10-74
East fork of west fork									
near mouth	5S	16E	35	500	Eb	3	4.0-6.3	1,2	7-10-74
West Fishtail Creek									
near ditch headgate	5S	16E	27	500	Eb	11	3.6-8.5	1,2,3	8-12-74
3.5 miles above mouth	5S	16E	27	400	-	0	-	-	8-12-74
Little Rocky Creek									
near mouth	4S	16E	28	700	LL	43	4.9-12.7	1,2,3,4	7-19-74
					Rb	2	6.5-8.7	-	
					LnSu	1	16.2	-	
					Lnd	4	4.0-5.5	-	
at Forest Service Camp	5S	16E	21	500	-	0	-	-	7-18-74
West fork near mouth	5S	16E	29	500	-	0	-	-	7-11-74
West fork above Benbow Mine	5S	16E	31	500	-	0	-	-	7-18-74
East fork near mouth	5S	16E	29	500	-	0	-	-	7-11-74
East fork near road crossing	5S	16E	32	500	-	0	-	-	7-11-74
South Nye Creek-near mouth	5S	15E	15	1850	-	0	-	-	6-08-72
Nye Creek-lower Nye basin	5S	15E	22,23	1000	-	0	-	-	6-11-74
Vedigris Creek									
near mouth	5S	15E	28	1520	-	0	-	-	6-13-72
near wood culvert above gossan	5S	15E	20	500	-	0	-	-	7-19-74
Mountain View Creek									
0.75 miles above mouth	5S	15E	21	500	-	0	-	-	6-12-74
outlet of Mountain View Lake	5S	15E	20	640	Lake Chub	1	3.5	-	6-12-74

a- Abbreviations are: Rb=Rainbow Trout; Ct=Cutthroat Trout; Eb=Brook Trout; LL=Brown Trout; LNSu=Longnose Sucker; Lnd=Longnose Dace

Appendix AA. Continued

Stream and location description	T	R	S	Stream section length (feet)	Species	Number caught	Length range (inches)	Fish age(s)	Date
Silver Creek									
just below east and west forks	5S	15E	16	450	LL	31	2.3-9.8	-	6-13-74
					Eb	2	3.3-3.9	-	
South fork 0.25 miles above mouth	5S	15E	16	250	LL	17	2.1-6.9	-	6-13-74
North fork 0.25 miles above mouth	5S	15E	16	200	LL	4	5.0-6.8	-	6-13-74
					Eb	1	4.2	-	
Iron Creek									
0.5 miles above mouth	5S	14E	11	1600	Rb	32	3.6-11.2	1,2,3,4	9-6,7,17-7
one mile above mouth	5S	14E	11	500	-	0	-	-	8-16-74
meadow 2 miles east of Iron Mountain	5S	14E	8	1000	-	0	-	-	7-31-74
South fork near mouth	5S	14E	7	500	-	0	-	-	7-31-74
North fork near mouth	5S	14E	7	500	-	0	-	-	7-31-74
Initial Creek near mouth	5S	14E	13,14	900	-	0	-	-	7-12-72
Cathedral Creek near mouth	5S	14E	14	900	Rb	1	5.5	-	7-12-72
Picket Pin Creek									
near Bear Pen Creek	4S	14E	36	500	Ct-Rb hybrid	1	12.1	4	7-30-74
					Eb	1	8.4	2	
1.5 miles below old sawmill	5S	14E	2	500	Rb	3	7.3-10.5	3,4	8-28-72
near road crossing	5S	14E	3	250	Rb	3	7.2-9.4	3,4	8-28-72
South fork near mouth	5S	14E	3	500	-	0	-	-	7-30-74
North fork near mouth	5S	14E	3	500	-	0	-	-	7-30-74
outlet of South Picket Pin Lake	5S	14E	6	500	-	0	-	-	7-30-74
East Boulder River									
near Canyon Creek	4S	13E	14	700	Rb	9	3.8-8.7	1,2,3,4	8-5-74
					Rb-Ct hybrid	5	4.2-11.3	1,2,4	
					LL	1	10.2	5+	
near Brownlee Creek	4S	13E	26	500	-	0	-	-	8-6-74
one mile above Brownlee Creek	4S	13E	35	1500	-	0	-	-	8-9-74
one mile below road crossing	4S	13E	35	500	-	0	-	-	8-9-74

Stream and location description	T	R	S	Stream section length (feet)	Species	Number caught	Length range (inches)	Fish age(s)	Date
East Boulder River continued									
Placer Basin road crossing	5S	13E	11	1500	Ct[b]	4	6.3-7.5	-	8-24-72
Placer Basin road crossing	5S	13E	11	1500	Ct[b]	1	10.8	-	8-01-74
one mile above road crossing	5S	13E	11,14	500	-	0	-	-	8-20-74
East fork near mouth	5S	13E	14	500	-	0	-	-	8-20-74
West fork near mouth	5S	13E	14	500	-	0	-	-	8-20-74
Forge Creek									
near mouth	5S	13E	2	500	Ct[b]	1	10.1	-	8-01-74
North fork near mouth	5S	13E	3	500	-	0	-	-	8-19-74
South fork near mouth	5S	13E	3	500	-	0	-	-	8-19-74
Brownlee Creek									
near mouth	4S	13E	26	500	Ct	1	9.6	-	8-06-74
one mile above mouth	4S	13E	27	500	-	0	-	-	8-08-74
two miles above mouth	4S	13E	27	500	-	0	-	-	8-08-74
East Chippy Creek									
near mouth	5S	12E	1	400	-	0	-	-	5-16-74
1.5 miles above mouth	5S	13E	6	500	-	0	-	-	8-19-74
Blakely Creek									
near mouth	4S	12E	26	500	Rb	20	1.7-9.9	0,1,2,3	6-21-73
					Eb	1	3.8	1	
1000 feet above mouth	4S	12E	25	400	-	0	-	-	6-21-73
2 miles above mouth	4S	13E	30	500	-	0	-	-	8-15-74
Graham Creek									
near mouth	4S	12E	14	1000	-	0	-	-	6-21-73
trail crossing 1.5 miles above mouth	4S	12E	24	500	-	0	-	-	8-13-74
Falls Creek-near mouth	14S	12E	15	500	Eb	1	6.2	-	5-16-74
Great Falls Creek	4S	12E	23	900	Rb	6	5.1-8.0	1,2,3	5-16-74
					Eb	4	5.6-8.7	1,2	

b- Fish of hatchery origin.

Appendix AA. Continued

Stream and location description	Date	T R S	Steam section length (feet)	Species	Number caught	length range (inches)	Test age(s)
Castle Creek-above mouth of Pass Creek	7/28/75	4S 14E 25	250	-	0	-	-
Saderbalm Creek near mouth	8/4/75	5S 14E 22	300	Rb	19	3.4-9.9	-
Hawley Creek near mouth	8/5/75	5S 12E 35	300	-	-[c]	-	-
Froze-to-Death Creek near mouth	8/5/75	4S 12E 10	400	Eb	1	6.0	-

c). Saw one Rainbow trout approximately 7" long, but this fish was not captured.

Appendix BB. Concentration (microgram/gram wet weight) of metals in fish muscle tissue.

Species[a]	Length (inches)	Weight (pounds)	Mercury	Copper	Nickel	Cadmium	Lead
			Fishtail Creek-Section F-11 - July 1972				
Rb[b]	4-5	-	<0.05	0.4	2.4	0.1	<1
Rb	6.5	0.10	<0.05	0.4	3.5	0.2	<1
Rb	6.5	0.14	<0.05	0.2	1.0	<0.1	<1
Rb	6.8	0.12	<0.05	0.2	1.0	0.1	<1
Rb	8.0	0.20	<0.05	0.2	<0.5	<0.1	<1
Rb	8.0	0.19	<0.05	-	<0.5	<0.1	<1
Rb	9.6	0.32	<0.05	0.1	1.5	<0.1	<1
Rb	10.0	0.38	<0.05	0.2	1.0	0.1	<1
Rb	11.8	0.65	<0.05	0.1	1.0	0.1	<1
Rb	13.0	0.78	<0.05	0.4	<0.5	<0.1	<1
LL[b]	4-5	-	<0.05	0.1	<0.5	<0.1	<1
LL[b]	4-5	-	<0.05	0.2	1.0	0.2	<1
LL	6.5	0.10	<0.05	0.1	1.0	0.2	-
LL	6.6	0.10	<0.05	0.2	1.0	<0.1	<1
LL	7.0	0.11	<0.05	0.4	1.5	0.2	<1
LL	7.4	0.16	<0.05	-	<0.5	0.1	<1
LL	8.8	0.22	<0.05	0.2	<0.5	0.2	<1
LL	9.3	0.32	<0.05	0.3	<0.5	<0.1	<1
LL	9.7	0.34	<0.05	0.1	1.0	<0.1	<1
LL	9.9	0.38	-	0.2	<0.5	<0.1	<1
LL	12.0	0.64	-	0.4	<0.5	<0.1	<1
LL	12.2	0.72	<0.05	0.2	<0.5	<0.1	<1
LL	12.5	0.80	<0.05	0.1	<0.5	<0.1	<1
LL	15.3	1.47	<0.05	0.1	<0.5	0.1	<1
Eb	7.5	0.20	<0.05	0.1	<0.5	<0.1	<1
Eb	7.7	0.20	<0.05	<0.1	<0.5	0.1	<1
Eb	10.7	0.50	<0.05	0.5	1.0	0.2	<1
Wf	15.0	1.30	<0.05	0.1	<0.5	<0.1	<1
			Stillwater River-Section F-1 - May 1972				
Rb[b]	<5.0	-	<0.05	<0.5	<0.5	0.2	<1
Rb	7.4	0.12	<0.05	0.5	1.5	0.2	<1
Rb	7.8	0.14	<0.05	0.5	1.0	0.1	<1
Rb	7.8	-	<0.05	<0.5	1.0	0.1	<1
Rb	11.1	0.51	0.15	<0.5	0.5	0.6	<1
Rb	13.3	0.81	0.45	<0.5	0.5	0.6	<1
LL	6.8	0.11	<0.05	<0.5	<0.5	0.2	<1
LL	7.1	0.13	<0.05	<0.5	0.5	0.2	<1
LL	8.1	0.21	<0.05	0.6	<0.5	0.5	<1
LL	13.3	0.64	0.20	<0.5	<0.5	0.5	<1
LL	13.5	0.86	<0.05	0.5	3.5	<0.1	<1

Species[a]	Length (inches)	Weight (pounds)	Mercury	Copper	Nickel	Cadmium	Lead
			Stillwater River- Section F-1 (con'd)				
Eb[b]	< 5.0	-	< 0.05	< 0.5	0.5	0.2	< 1
Eb	6.6	0.10	0.4	< 0.5	< 0.5	0.5	< 1
Eb	7.3	0.12	< 0.05	< 0.5	0.5	0.2	< 1
Eb	7.8	0.14	< 0.05	-	-	-	-
Eb	8.3	0.18	< 0.05	3.4	1.0	0.3	< 1
Eb	8.5	0.21	< 0.05	< 0.5	< 0.5	0.3	< 1
Eb	8.6	0.20	< 0.05	-	1.0	-	< 1
Wf[b]	< 6.0	-	< 0.05	< 0.5	0.5	0.3	< 1
Wf	9.8	0.40	< 0.05	0.5	0.5	0.6	< 1
Wf	10.1	0.34	< 0.05	0.6	1.0	0.5	< 1
Wf	10.9	0.40	< 0.05	< 0.5	< 0.5	0.5	< 1
Wf	11.3	0.38	< 0.05	0.8	1.5	0.1	< 1
Wf	12.6	0.59	< 0.05	< 0.5	0.5	0.9	-
Wf	13.7	0.68	< 0.05	0.7	0.5	0.3	< 1
Wf	13.7	0.70	< 0.05	< 0.5	1.5	0.7	< 1
			Stillwater River-Section F-2 - April, 1972				
Rb[b]	< 6.0	-	< 0.05	1.1	1.6	0.6	< 2	28
Rb	7.5	0.15	< 0.05	< 0.5	4.2	< 0.5	< 2	9.0
Rb	9.0	0.28	< 0.05	0.9	1.4	< 0.5	< 2	9.5
Rb	9.1	0.30	< 0.05	0.9	2.4	0.6	< 2	7.5
Rb	9.7	0.38	< 0.05	0.7	1.6	0.6	< 2	5.0
Rb	10.6	0.40	< 0.05	1.1	2.6	0.7	< 2	12
Rb	12.5	0.60	< 0.05	< 0.5	2.0	1.0	< 2	4.5
Rb	14.8	1.00	< 0.05	0.9	< 1.0	< 0.5	< 2	7.5
Rb	15.3	1.22	< 0.05	1.0	1.6	1.0	< 2	7.0
Rb	15.4	1.30	< 0.05	< 0.5	< 1.0	0.6	< 2	4.5
Rb	17.4	2.16	< 0.05	1.4	< 1.0	< 0.5	< 2	7.0
Eb[b]	< 6.0	-	< 0.05	0.6	< 1.0	< 0.5	< 2	13
Eb	6.3	0.12	< 0.05	< 0.5	1.4	< 0.5	< 2	7.0
Eb	6.4	0.08	< 0.05	0.8	2.0	0.6	< 2	16
Eb	6.8	0.09	< 0.05	0.7	< 1.0	< 0.5	< 2	13
Eb	7.1	0.10	< 0.05	1.5	1.0	< 0.5	< 2	15
Eb	8.5	0.18	< 0.05	0.6	1.8	< 0.5	< 2	8.5
Eb	8.8	0.25	< 0.05	0.7	1.4	0.6	< 2	14
Eb	9.3	0.26	< 0.05	0.7	3.4	< 0.5	< 2	4.5
Eb	11.1	0.40	< 0.05	< 0.5	2.8	< 0.5	< 2	16
LL[b]	< 6.0	-	< 0.05	1.3	1.2	0.8	< 2	10
LL	6.4	0.13	< 0.05	1.3	1.1	< 0.5	< 2	17
LL	6.4	0.08	< 0.05	0.6	< 1.0	< 0.5	< 2	12
LL	7.8	0.20	< 0.05	0.6	< 1.0	< 0.5	< 2	5.5
LL	7.8	0.18	< 0.05	1.4	1.2	< 0.5	< 2	16
LL	10.3	0.34	< 0.05	< 0.5	3.5	0.6	< 2	14
LL	10.3	0.35	< 0.05	< 0.5	4.0	0.6	< 2	8.0
LL	10.8	0.44	< 0.05	0.6	1.1	< 0.5	< 2	4.5
LL	12.9	0.71	< 0.05	< 0.5	2.8	1.0	< 2	16
LL	15.5	1.30	< 0.05	0.7	1.3	< 0.5	< 2	4.0
LL	15.6	1.05	< 0.05	0.9	< 1.0	0.6	3	7.5
LL	15.7	1.22	< 0.05	0.7	1.1	< 0.5	< 2	4.0
LL	15.7	1.28	< 0.05	1.2	< 1.0	0.6	< 2	22

Boulder River-Section F-4 - April, 1972

Rb[b]	< 5.0	-	< 0.05	0.5	0.5	0.3	< 1
Rb	5.6	0.05	0.11	0.5	< 0.5	0.7	1.5
Rb	7.0	0.15	< 0.05	0.5	0.5	0.2	< 1
Rb	7.1	0.15	< 0.05	0.5	1.0	0.5	< 1
Rb	8.3	0.21	< 0.05	< 0.5	1.0	0.3	< 1
Rb	8.7	0.23	< 0.05	< 0.5	< 0.5	0.1	< 1
Rb	8.7	0.22	< 0.05	< 0.5	0.5	0.2	< 1
Rb	12.4	0.72	< 0.05	< 0.5	< 0.5	0.3	< 1
Rb	13.4	0.88	< 0.05	< 0.5	0.5	0.2	< 1
Rb	15.4	1.35	< 0.05	-	-	-	-
Rb	17.5	2.05	< 0.05	0.5	1.0	0.5	1
Rb	17.7	1.96	< 0.05	< 0.5	< 0.5	0.1	< 1
Rb	18.0	1.80	< 0.05	< 0.5	< 0.5	< 0.1	< 1
Rb	21.6	3.18	< 0.05	< 0.5	< 0.5	0.1	< 1
Eb[b]	< 5.0	-	< 0.05	0.5	< 0.5	0.3	< 1
Eb	5.8	.07	< 0.05	< 0.5	< 0.5	0.1	< 1
Eb	6.0	.07	< 0.05	< 0.5	< 0.5	-	< 1
Eb	6.1	.08	< 0.05	< 0.5	< 0.5	< 0.1	< 1
Eb	7.6	.13	< 0.05	< 0.5	< 0.5	< 0.1	< 1
Eb	8.1	.14	< 0.05	< 0.5	< 0.5	< 0.1	< 1
Eb	8.7	.19	< 0.05	< 0.5	< 0.5	0.1	< 1
Eb	9.2	.22	< 0.05	< 0.5	0.5	0.4	1
Eb	9.8	.30	< 0.05	< 0.5	< 0.5	< 0.1	< 1

Appendix BB. Continued

Species[a]	Length (inches)	Weight (pounds)	Mercury	Copper	Nickel	Cadmium	Lead	Arsenic	Zinc
West Fork Stillwater River - Section F-28 - October 1975									
Rb[b]	4.0-5.0	--	--	<0.25	<1.0	<0.25	<0.25	0.57	9.1
Rb	6.0	0.09	--	<0.25	<1.0	<0.25	<0.25	<0.25	9.4
Rb	6.4	0.11	<0.1	0.43	<1.0	<0.25	<0.25	<0.25	10.0
Rb	6.6	0.12	--	0.58	<1.0	<0.25	<0.25	<0.25	6.8
Rb	7.9	0.18	--	<0.25	1.1	<0.25	<0.25	<0.25	9.6
Rb	8.0	0.18	0.11	0.55	<1.0	<0.25	0.44	<0.25	5.6
Rb	8.6	0.21	--	0.31	<1.0	<0.25	<0.25	<0.25	11.0
Rb	8.9	0.27	<0.1	0.57	<1.0	<0.25	<0.25	<0.25	13.0
Rb	9.3	0.36	<0.1	0.54	<1.0	<0.25	0.32	0.81	13.0
Rb	9.7	0.37	--	0.34	<1.0	<0.25	<0.25	<0.25	5.4
Rb	10.0	0.37	<0.1	0.44	<1.0	<0.25	<0.25	<0.25	8.9
Rb	10.0	0.38	--	0.27	<1.0	<0.25	<0.25	<0.25	5.5
West Fork Stillwater River - Section F-26 - May 1975									
Rb[b]	3.0-4.9	--	--	0.14	<0.5	<0.1	<0.25	<0.25	9.8
Rb	6.7	0.12	--	<0.1	0.74	<0.1	<0.25	<0.25	5.4
Rb	7.3	0.13	--	<0.1	<0.5	<0.1	<0.25	<0.25	6.6
Rb	7.4	0.18	--	0.35	<0.5	<0.1	<0.25	0.49	4.4
Rb	9.2	0.28	--	0.13	0.58	<0.1	<0.25	<0.25	4.4
Rb	9.2	0.31	--	0.28	<0.5	<0.1	<0.25	<0.25	4.6
Rb	9.4	0.30	--	0.14	<0.5	<0.1	<0.25	<0.25	4.7
Rb	9.7	0.33	--	0.28	<0.5	<0.1	<0.25	0.29	5.0
Rb	10.2	0.43	--	0.18	0.71	<0.1	<0.25	<0.25	4.5
Rb	11.2	0.54	--	0.24	0.51	<0.1	<0.25	0.25	5.9
West Fork Stillwater River - Section F-29 - November 1975									
Rb[b]	4.0-5.0	--	--	0.67	<1.0	<0.25	<0.25	<0.25	6.6
Rb	6.1	0.07	<0.1	0.50	<1.0	<0.25	0.25	0.25	7.0
Rb	6.6	0.12	<0.1	0.71	<1.0	<0.25	<0.25	<0.25	5.7
Rb	7.0	0.14	<0.1	0.95	<1.0	<0.25	<0.25	<0.25	7.7
Rb	8.8	0.23	<0.1	0.42	<1.0	<0.25	<0.25	<0.25	5.6
Rb	9.1	0.28	<0.1	0.59	<1.0	<0.25	<0.25	<0.25	4.6
Rb	10.1	0.44	<0.1	0.48	<1.0	<0.25	<0.25	<0.25	6.3
Rb	11.1	0.61	<0.1	0.89	<1.0	<0.25	<0.25	<0.25	6.8

Appendix BB. Continued

Species[a]	Length (inches)	Weight (pounds)	Mercury	Copper	Nickel	Cadmium	Lead	Arsenic	Zinc
		West Fork Stillwater River - Section F-29 - November 1975							
Rb	12.0	0.66	<0.1	<0.25	<1.0	<0.25	<0.25	0.54	4.3
Rb	13.1	0.79	<0.1	0.47	<1.0	<0.25	<0.25	<0.25	5.4
LL	6.2	0.09	<0.1	0.70	<1.0	<0.25	<0.25	<0.25	14.0
LL	6.5	0.10	<0.1	0.45	<1.0	<0.25	<0.25	<0.25	17.0
LL	7.1	0.12	<0.1	0.64	<1.0	<0.25	<0.25	<0.25	11.0
LL	10.6	0.45	<0.1	0.49	<1.0	<0.25	<0.25	0.25	8.9
LL	10.9	0.39	<0.1	0.49	<1.0	<0.25	<0.25	<0.25	8.5
LL	11.7	0.57	<0.1	0.59	<1.0	<0.25	<0.25	1.0	19.0
LL	11.7	0.71	<0.1	0.57	<1.0	<0.25	<0.25	1.2	3.4
LL	11.9	0.65	<0.1	0.53	<1.0	<0.25	<0.25	<0.25	4.3
		West Fork Stillwater River - Section F-17 - September 1973							
Rb[b]	4.0-5.5	--	1.0	<0.5	<1.0	<0.5	<5.0	--	30 0
Rb	6.2	0.09	0.2	<0.5	2.0	<0.5	<5.0	--	15.0
Rb	6.7	0.12	1.3	<0.5	<1.0	<0.5	<5.0	--	27.0
Rb	6.8	0.11	0.4	<0.5	<1.0	<0.5	9.0	--	2.3
Rb	6.8	0.15	2.1	<0.5	2.0	<0.5	<5.0	--	33.0
Rb	7.0	0.14	0.6	<0.5	<1.0	0.5	5.0	--	45.0
Rb	7.0	0.15	0.4	0.9	<1.0	<0.5	<5.0	--	<1.0
Rb	8.2	0.22	1.0	<0.5	3.0	<0.5	<5.0	--	<1.0
Rb	8.4	0.23	0.8	0.9	3.0	<0.5	<5.0	--	35.0
Rb	8.4	0.26	1.3	<0.5	2.0	<0.5	<5.0	--	4.1
Rb	8.5	0.23	2.7	<0.5	4.0	<0.5	11.0	--	33.0
Rb	8.7	0.31	0.2	<0.5	2.0	<0.5	<5.0	--	<1.0
Rb	8.8	0.30	1.0	0.8	3.0	<0.5	16.0	--	32.0
Rb	8.8	0.33	0.4	0.6	2.0	<0.5	5.0	--	<1.0

Appendix BB. Continued

Species[a]	Length (inches)	Weight (pounds)	Mercury	Copper	Nickel	Cadmium	Lead	Arsenic	Zinc
		West Fork Stillwater River - Section F-17 - October 1975							
Rb	6.0	0.08	--	0.25	<1.0	<0.25	<0.25	0.40	7.4
Rb	6.0	0.09	--	0.25	<1.0	<0.25	<0.25	0.49	2.5
Rb	6.3	0.11	<0.1	0.53	<1.0	<0.25	<0.25	<0.25	32.0
Rb	7.8	0.17	--	0.51	<1.0	<0.25	<0.25	0.46	7.7
Rb	8.0	0.18	--	<0.25	1.3	<0.25	<0.25	<0.25	7.2
Rb	8.4	0.23	--	0.47	<1.0	<0.25	<0.25	<0.25	9.0
Rb	9.0	0.30	--	0.47	<1.0	<0.25	<2.5	<0.25	1.9
Rb	9.3	0.30	--	0.57	<1.0	<0.25	<0.25	<0.25	19.0
Rb	10.0	0.40	--	0.43	<1.0	--	<0.25	<0.25	6.4
Rb	10.1	0.42	--	0.51	<1.0	<0.25	<0.25	<0.25	12.0
		Castle Creek - Section F-25 - November 1975							
LL[b]	3.5-5.0	--	--	0.56	<1.0	<0.25	<0.25	<0.25	10.0
LL	5.4	0.06	<0.1	<0.25	<1.0	<0.25	<0.25	0.49	8.3
LL	6.2	0.09	--	<0.25	<1.0	<0.25	<0.25	<0.25	9.6
LL	6.9	0.13	0.34	0.46	1.0	<0.25	<0.25	0.31	13.0
LL	7.8	0.18	--	0.57	<1.0	<0.25	<0.25	<0.25	4.8
LL	8.2	0.21	--	0.58	<1.0	<0.25	<0.25	0.44	3.9
LL	8.2	0.23	<0.1	0.50	<1.0	<0.25	<0.25	0.55	16.0
LL	10.0	0.38	<0.1	<0.25	<1.0	<0.25	<0.25	0.27	1.8
LL	11.0	0.53	--	<0.25	<1.0	<0.25	<0.25	0.59	15.0
LL	11.1	0.50	--	0.58	<1.0	<0.25	<0.25	0.25	10.0
Eb	5.6	0.07	<0.1	0.51	<1.0	<0.25	<0.25	0.51	14.0
Eb	5.9	0.08	--	0.71	<1.0	<0.25	<0.25	<0.25	10.0
Eb	6.1	0.09	--	0.25	<1.0	<0.25	0.25	<0.25	11.0
Eb	6.1	0.09	--	0.50	<1.0	<0.25	<0.25	<0.25	11.0
Eb	7.1	0.15	--	0.47	<1.0	<0.25	<0.25	0.32	8.4
Eb	7.9	0.20	--	0.55	<1.0	<0.25	<0.25	1.1	6.9
Eb	8.2	0.23	--	0.48	<1.0	<0.25	<0.25	<0.25	11.0
Eb	8.8	0.23	--	<0.25	<1.0	<0.25	<0.25	<0.25	18.0

Appendix BB. Continued

Species[a]	Length (inches)	Weight (pounds)	Mercury	Copper	Nickel	Cadmium	Lead	Arsenic	Zinc
		Castle Creek - Section F-27 - November 1975							
LL[b]	4.0-5.0	--	<0.1	0.59	<1.0	<0.25	<0.25	<0.25	12.0
LL	6.1	0.09	<0.1	0.80	<1.0	<0.25	<0.25	<0.25	9.9
LL	6.6	0.11	<0.1	0.98	<1.0	<0.25	<0.25	<0.25	14.0
LL	6.7	0.12	<0.1	0.25	<1.0	<0.25	<0.25	<0.25	11.0
LL	7.8	0.18	<0.1	0.56	<1.0	<0.25	<0.25	<0.25	7.0
LL	8.5	0.24	<0.1	0.70	<1.0	<0.25	<0.25	<0.25	5.2
LL	8.6	0.25	<0.1	0.93	<1.0	<0.25	<0.25	<0.25	7.1
LL	10.3	0.38	<0.1	0.64	<1.0	<0.25	<0.25	<0.25	6.7
LL	10.5	0.42	<0.1	0.25	<1.0	<0.25	<0.25	<0.25	5.5
LL	10.7	0.47	<0.1	<0.25	<1.0	<0.25	4.1	<0.25	4.8
LL	11.6	0.58	<0.1	1.0	<1.0	<0.25	0.25	<0.25	7.0
LL	11.7	0.53	<0.1	0.62	<1.0	<0.25	<0.25	<0.25	4.5
		Castle Creek - Section F-23 - October 1975							
LL[b]	<5.0	--	--	0.25	<1.0	<0.25	<0.25	<0.25	8.6
LL	6.6	0.10	--	0.51	<1.0	<0.25	0.81	0.41	6.6
LL	6.8	0.10	--	0.52	<1.0	<0.25	<0.25	0.26	11.0
LL	7.6	0.16	--	<0.25	<1.0	<0.25	<0.25	<0.25	8.7
LL	8.4	0.23	--	0.57	<1.0	<0.25	<0.25	0.38	10.0
LL	8.8	0.22	--	0.52	<1.0	<0.25	<0.25	0.52	7.8
LL	9.2	0.27	--	0.53	<1.0	<0.25	<0.25	0.57	6.1
LL	10.5	0.42	--	<0.25	<1.0	<0.25	0.47	0.32	5.9
LL	10.5	0.47	<0.1	0.44	<1.0	<0.25	<0.25	<0.25	13.0
LL	11.3	0.50	<0.1	0.55	<1.0	<0.25	0.36	<0.25	6.4
LL	11.9	0.67	<0.1	<0.25	<1.0	<0.25	0.31	0.43	5.1
LL	11.9	0.69	--	0.46	<1.0	<0.25	0.28	<0.25	6.1
LL	13.9	0.94	<0.1	0.47	<1.0	<0.25	<0.25	0.28	7.1

Appendix BB. Continued

Species[a]	Length (inches)	Weight (pounds)	Mercury	Copper	Nickel	Cadmium	Lead	Arsenic	Zinc
Picket Pin Creek - Section F-16 - November 1975									
LL[b]	<5.0	--	<0.1	0.65	<1.0	<0.25	<0.25	<0.25	4.3
LL	6.2	0.08	<0.1	0.55	<1.0	<0.25	<0.25	0.35	15.0
LL	6.6	0.10	<0.1	0.64	<1.0	<0.25	<0.25	<0.25	6.9
LL	6.8	0.11	<0.1	0.71	<1.0	<0.25	<0.25	<0.25	12.0
LL	7.0	0.12	<0.1	0.68	<1.0	<0.25	<0.25	0.32	32.0
LL	7.8	0.20	<0.1	0.61	<1.0	<0.25	<0.25	<0.25	6.8
LL	9.1	0.29	<0.1	0.70	<1.0	<0.25	<0.25	<0.25	7.9
LL	10.9	0.44	<0.1	<0.25	<1.0	<0.25	<0.25	<0.25	7.0
LL	12.6	0.72	<0.1	0.61	<1.0	<0.25	<0.25	<0.25	5.2
Eb	5.0	--	<0.1	0.71	<1.0	<0.25	<0.25	<0.25	12.0
Eb	6.3	0.09	<0.1	0.76	1.3	<0.25	<0.25	<0.25	17.0
Eb	6.4	0.10	<0.1	0.50	<1.0	<0.25	<0.25	<0.25	6.3
Eb	6.4	0.11	<0.1	0.61	<1.0	<0.25	<0.25	0.25	20.0
Eb	6.9	0.10	<0.1	<0.25	<1.0	<0.25	<0.25	0.58	6.7
Eb	7.1	0.12	<0.1	0.25	<1.0	<0.25	<0.25	<0.25	6.0
Eb	7.6	0.15	<0.1	0.64	<1.0	<0.25	<0.25	0.25	8.9
Eb	8.8	0.24	<0.1	0.26	<1.0	<0.25	<0.25	<0.25	22.0

a- Abbreviations are: Rb=Rainbow Trout; Eb=Brook Trout; LL=Brown Trout; Wf=Mountain Whitefish
b- Composite of several fish.